JULY 1961

# Heating Piping & Air Conditioning

**. . . for Consulting Engineers • Mechanical (Heating, Piping, and Air Conditioning) Contractors • Engineers with Plants and Big Buildings**

ENGINEERING DATA FILE

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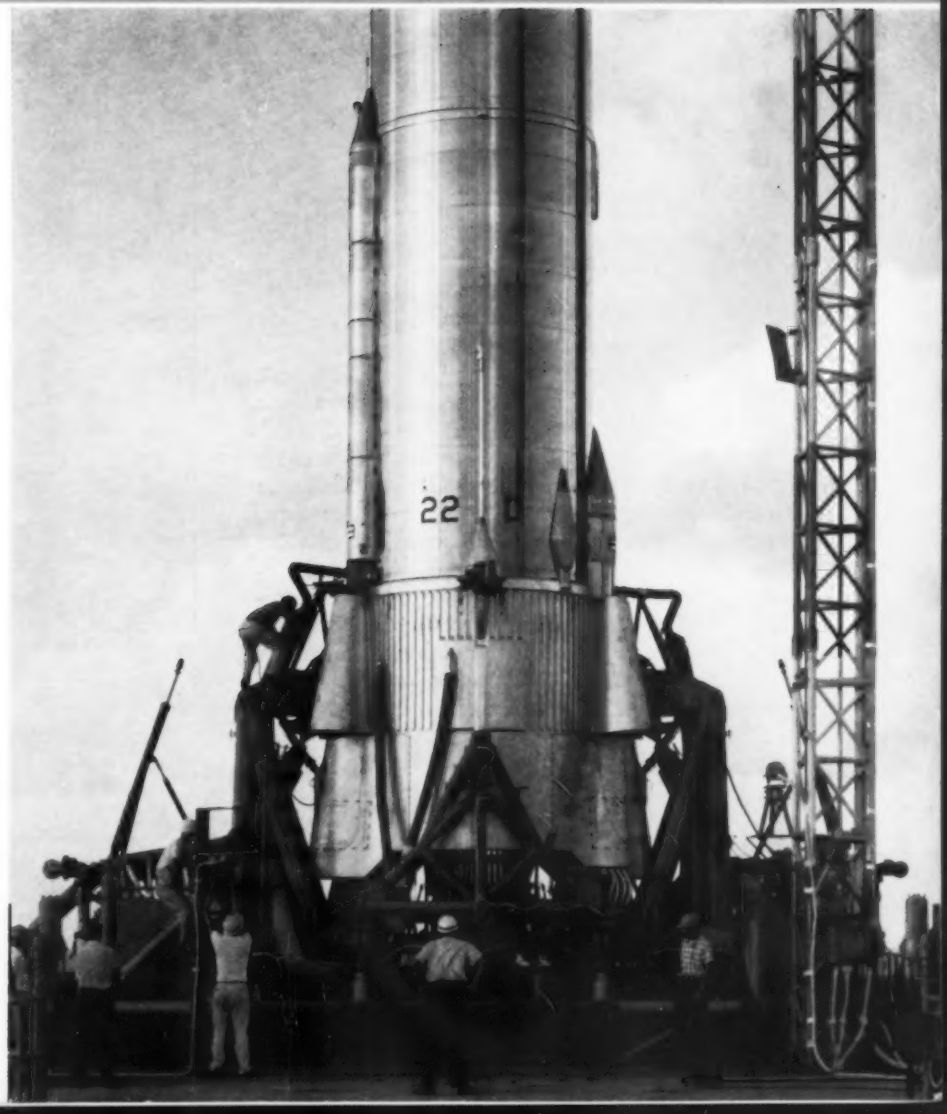

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# Heating, Piping & Air Conditioning

FOR CONSULTING ENGINEERS, MECHANICAL (HEATING, PIPING, AND AIR CONDITIONING) CONTRACTORS, ENGINEERS WITH PLANTS AND BIG BUILDINGS

VOL. 33, NO. 7 JULY 1961

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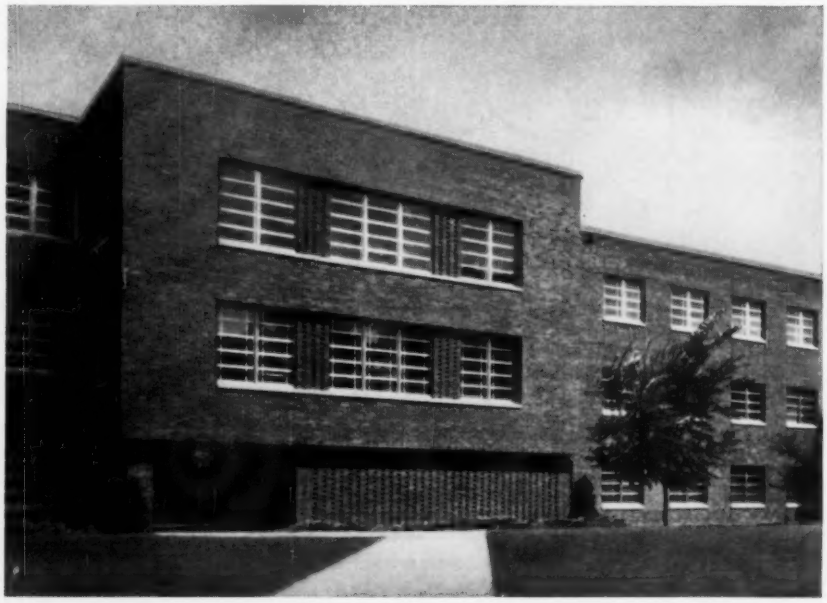
# How *Imaginative Engineering* Uses Pneumatic Temperature Control To Guarantee Year 'Round Patient Comfort

Scott & Kinney, Kansas City consulting engineers, took a new look at an old problem and designed a *different* heating and air conditioning system for the University of Kansas Psychiatry Building. Their unusual method features two separate fan systems and a unique automatic damper application that eliminates the noise and distribution problems usually encountered with ordinary single-fan systems.

Providing uniform year 'round temperature together with foolproof individual room control has always been a problem in designing buildings of this nature. But Scott & Kinney provided the solution in their selection and imaginative arrangement of a Powers Pneumatic Control System.



*Building "G", University of Kansas Medical Center*

**ARCHITECTS:**
*Kansas State Architectural Dept., Topeka, Kansas*

**CONSULTING ENGINEERS:**
*Scott & Kinney, Kansas City, Missouri*

**MECHANICAL CONTRACTOR:**
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*Final check on the U. of K. Psychiatry Building's pneumatic control system by the consulting engineers, Wilson O. Kinney (left) and Arthur R. Scott.*

Heating, ventilating and air conditioning are accomplished through primary and secondary air systems. The primary system operates throughout the year, supplying a small amount of circulated air, including outside air. Final control in the primary system is a reheat coil — one for each patient room — using hot water with a Powers modulating packless valve.

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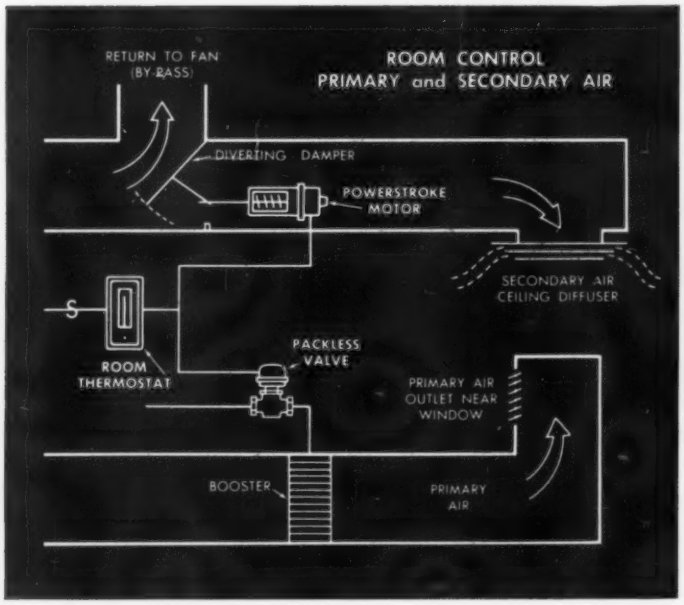


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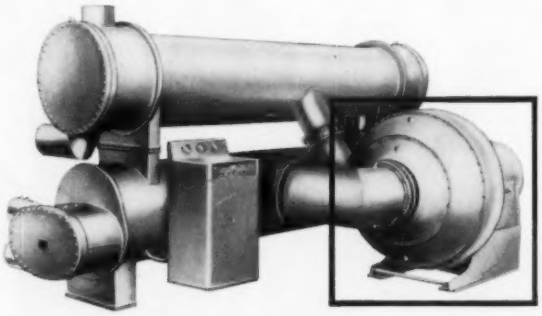

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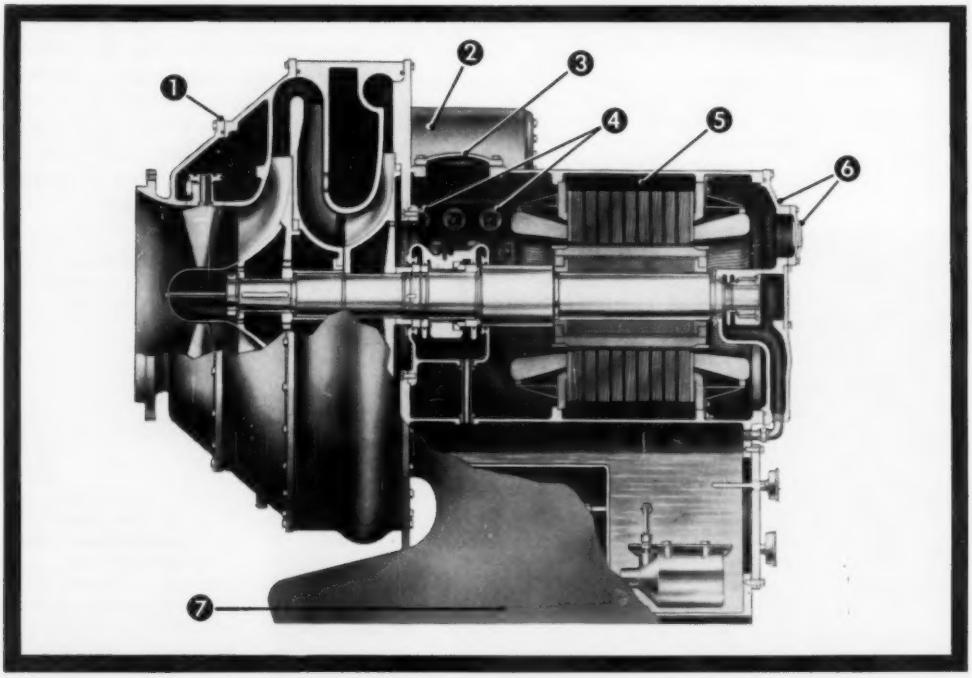


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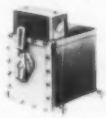
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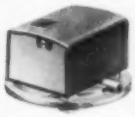
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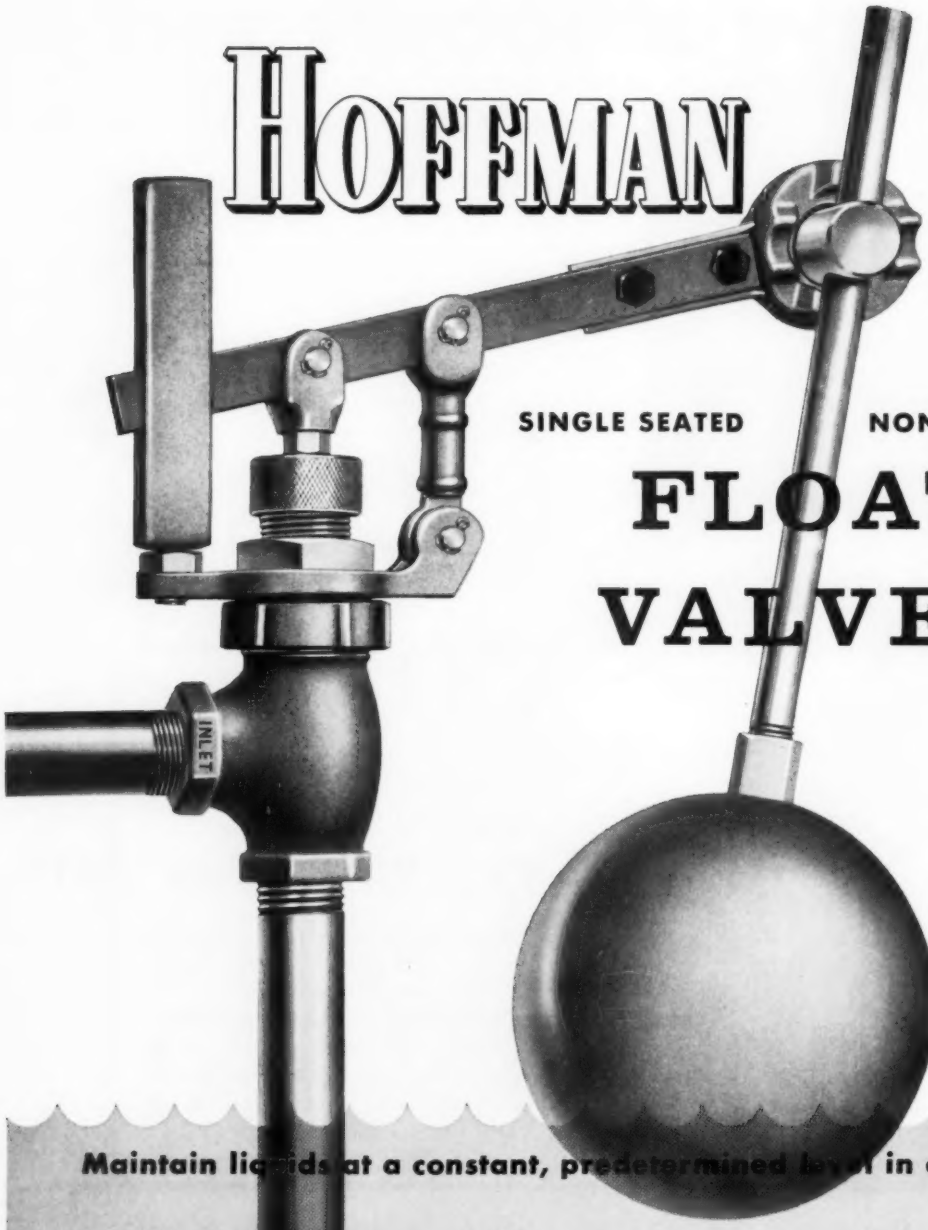


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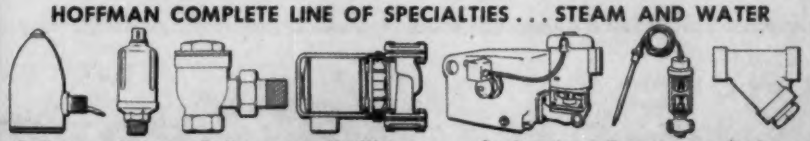

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# LETTER FROM THE EDITOR

July 1961

Dear Reader:

A simplified method for calculating expansion stresses in pipe bends is given on pages 109 to 112 this month. The author, C. A. Lee, has felt for some time that such a method should be made available to other engineers and contractors who must solve these problems without the use of a computer. Mr. Lee has used this method extensively in his piping design work and has found it to be accurate and a time saver too. Hope you'll find it to be helpful.

We've been hearing and reading a lot about missiles lately, and I'm sure we all realize what an important part air conditioning plays in the success of launching of these missiles. How this is done is related by Lester Ries in his interesting account on page 113 of what the systems do and how they operate in the launching of the Atlas missile. He assembled these facts on the site after several visits with the engineers and contractors doing the work.

In order to become better acquainted with the federal government operations in the construction field, especially the design, installation, and financing of heating, piping, and air conditioning systems, we asked Lewis Smith to prepare the article on pages 116 to 121. To get this information for you, he went to Washington and interviewed the men in the various agencies. This article will save you many hours and considerable expense when you find it essential or desirable to go to Washington. And even if you do not anticipate the need of establishing or maintaining business relations in Washington, I'm sure you will find Mr. Smith's article to be informative as it certainly reflects the scope of the government operations today in our field.

How to correct the negative pressure in an air conditioned building is explained by Joseph H. Jerrell in his article on page 122. Of course this negative pressure in air conditioned multi-story buildings is really a disease that robs comfort, and Mr. Jerrell details the steps necessary for diagnosing the problem and what should be done about it. I'd like to hear your experiences on this or similar problems too.

After hearing about the economies put into effect at the United States Plywood Corporation plant in Virginia, we asked Bill Smoots, mechanical engineer, to tell us what was being done and how it was accomplished. His article on page 125 contains many helpful tips that should be applicable to many other situations as well.

LETTER FROM THE EDITOR (Continued) --

The third and concluding article containing tables to permit the calculation of solar irradiation rates for forward-inclined walls is on pages 130 to 134. Many favorable comments have been received from engineers throughout the country about the value of these tables. Are you using them too?

Proper treatment of the air for bottling plants can make the operation as sanitary as it appears through the big glass windows, so common in these plants, according to John Shaw in his article on page 135. He says this can be accomplished in spite of the heat producing washing machines that many operators consider a deterrent to air conditioning. Mr. Shaw is secretary-treasurer of the standardization committee of the bottlers of Coca-Cola and in this article he reports what has been done in several bottling plants throughout the country.

A new piping component comparison chart is presented on pages 138 to 140 which should be a real aid in matching materials and specifications in basic piping systems. F. W. Holmes has made this available for publication in this issue, and I suggest that you clip and save it for your future use.

Temperature control of instantaneous heater systems should be both fast and accurate, according to Ernest Grafe. He explains how to achieve this in his article on page 141. This information will aid in a better understanding of what is involved in the control of these systems as Mr. Grafe discusses time lag, overheating, steam supply, sizing, and many other factors that must be considered.

How to prevent heating and cooling coils from freezing is explained in this month's Engineering Data File. Don Bahnfleth, HPAC Engineering Editor, has prepared this report after many pages of calculations, interviews, and checking with engineers, contractors, and manufacturers. The causes of coil freeze-ups are many, and in this report these are considered along with the ways to provide freeze protection in the design, installation, and operation of the systems containing these coils.

I believe the two answers to the Question of the Month on pages 105 and 106 will be of interest to you. If you have an answer to this question, or if you would like to comment on any of the articles for our information or for publication, drop a line to me about it.

Bob Roose

Editor, HEATING, PIPING & AIR CONDITIONING

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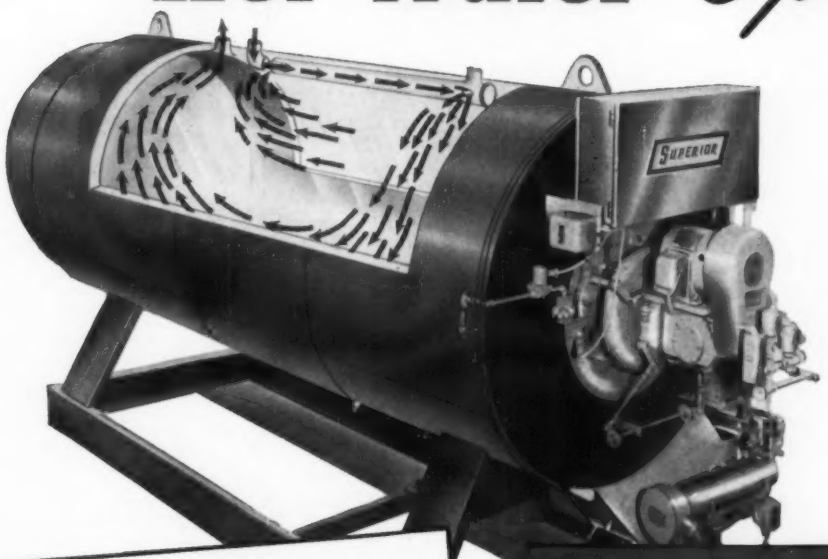


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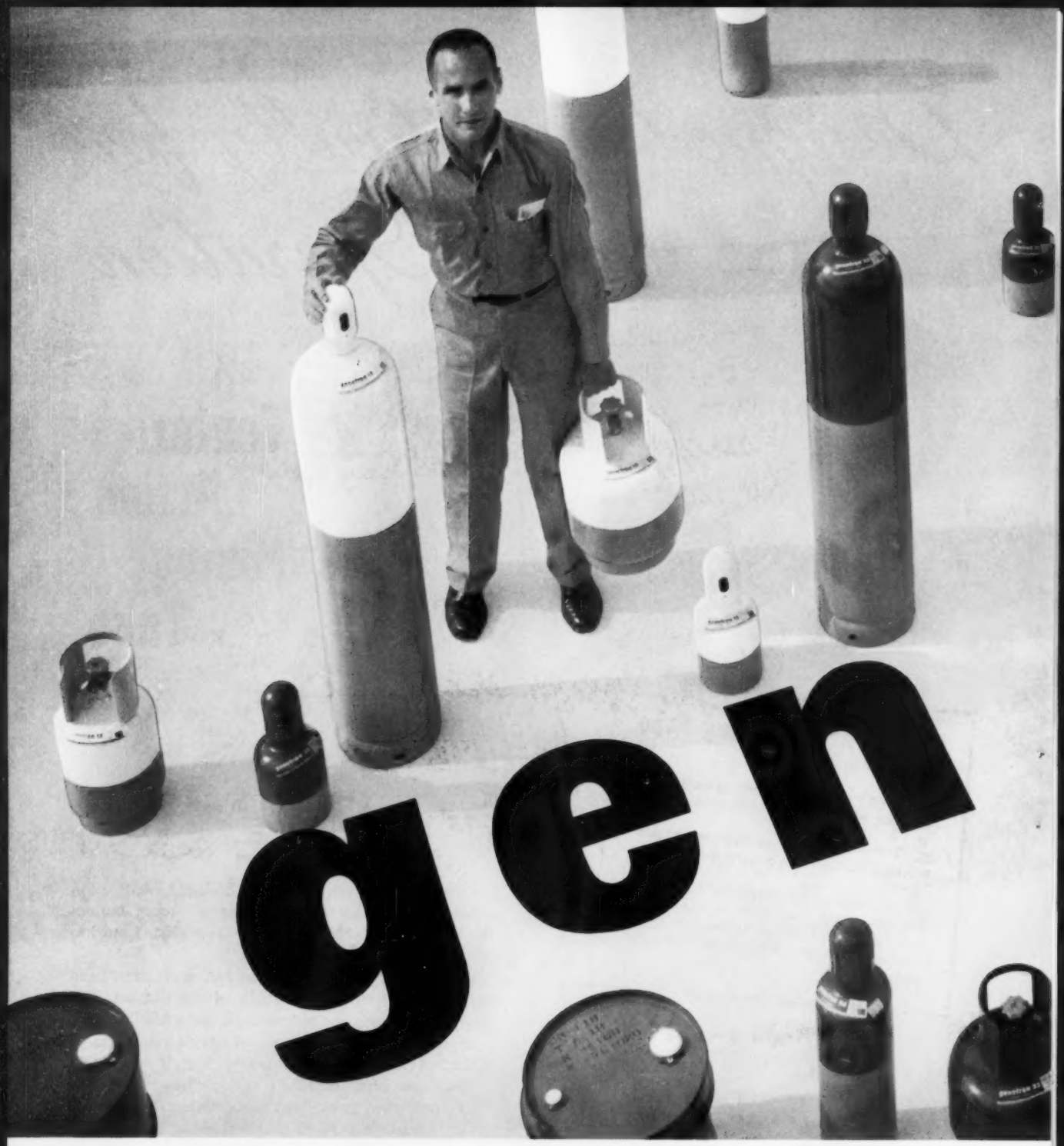


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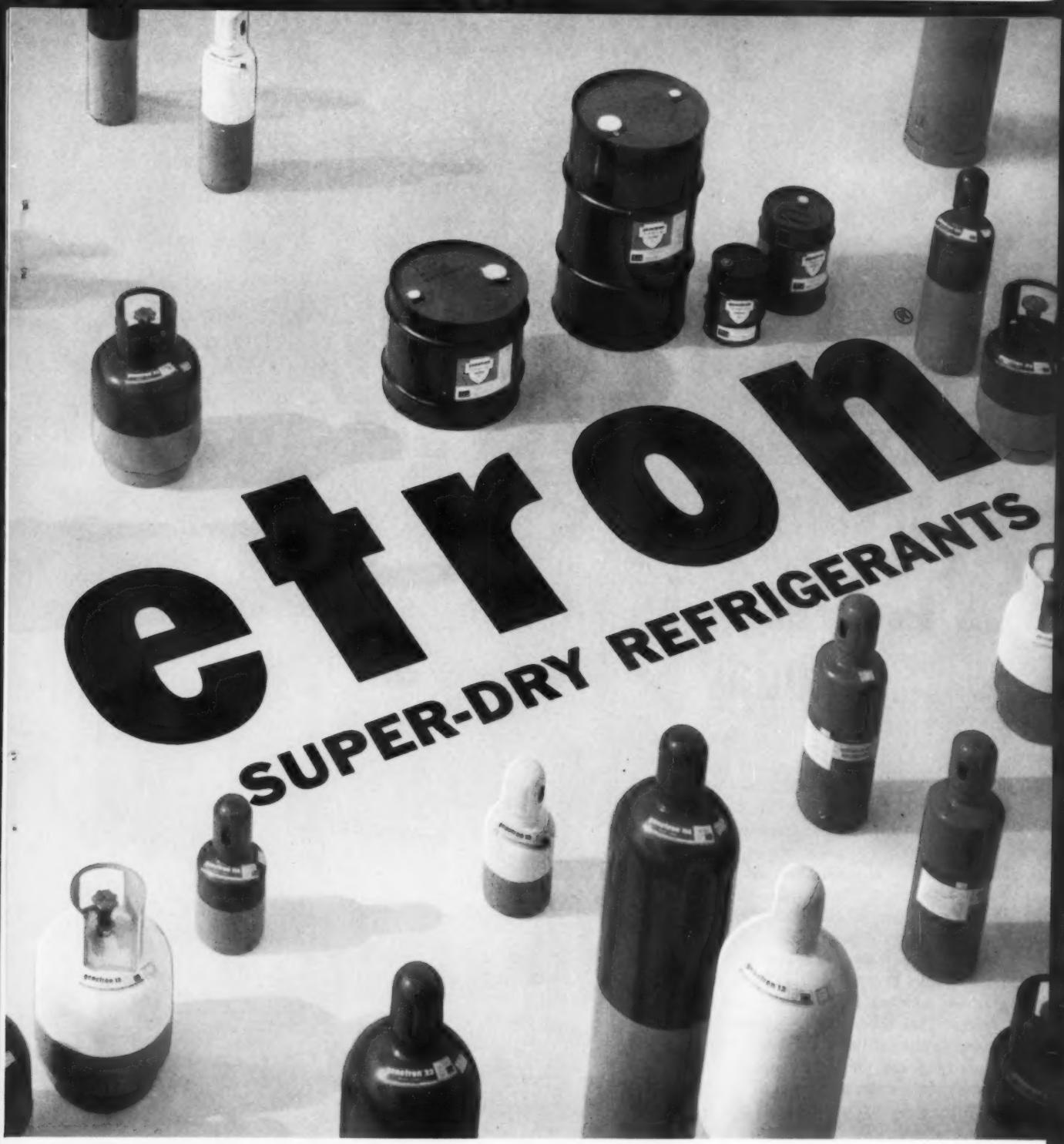


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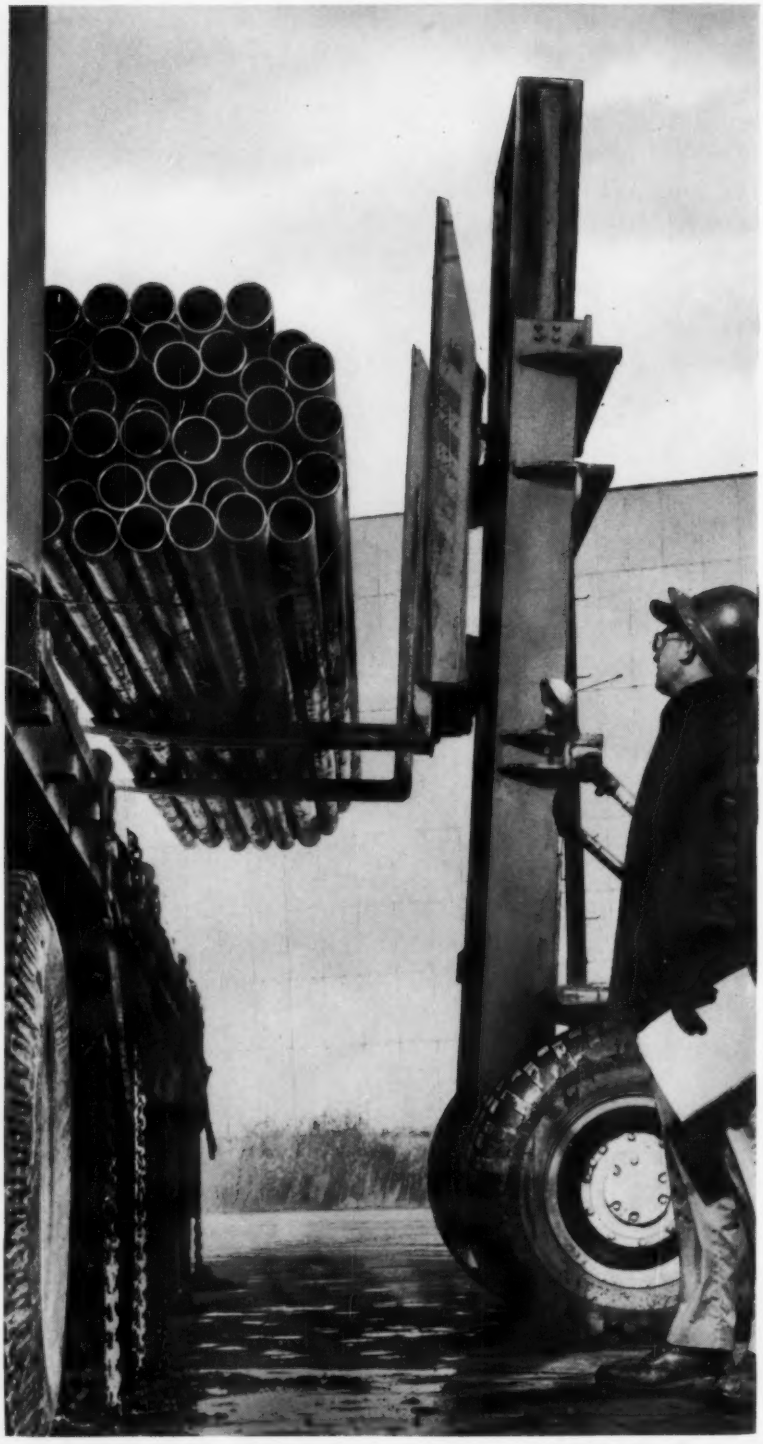

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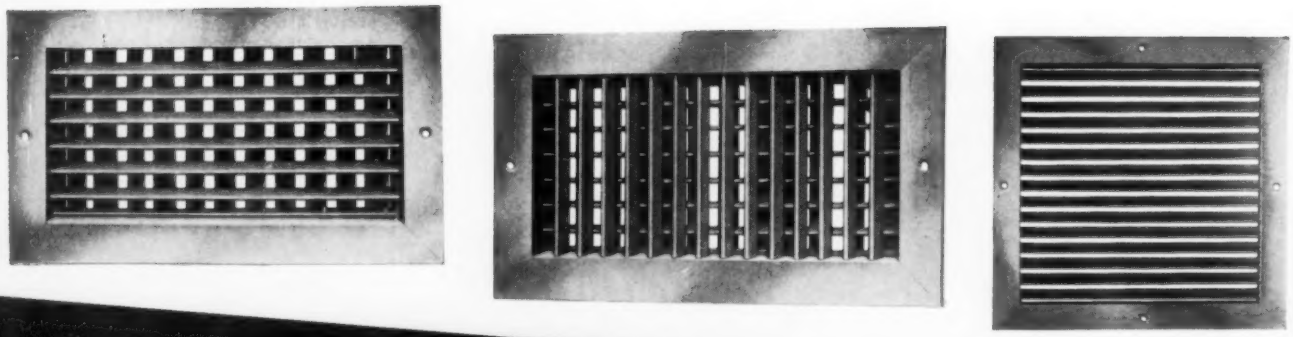

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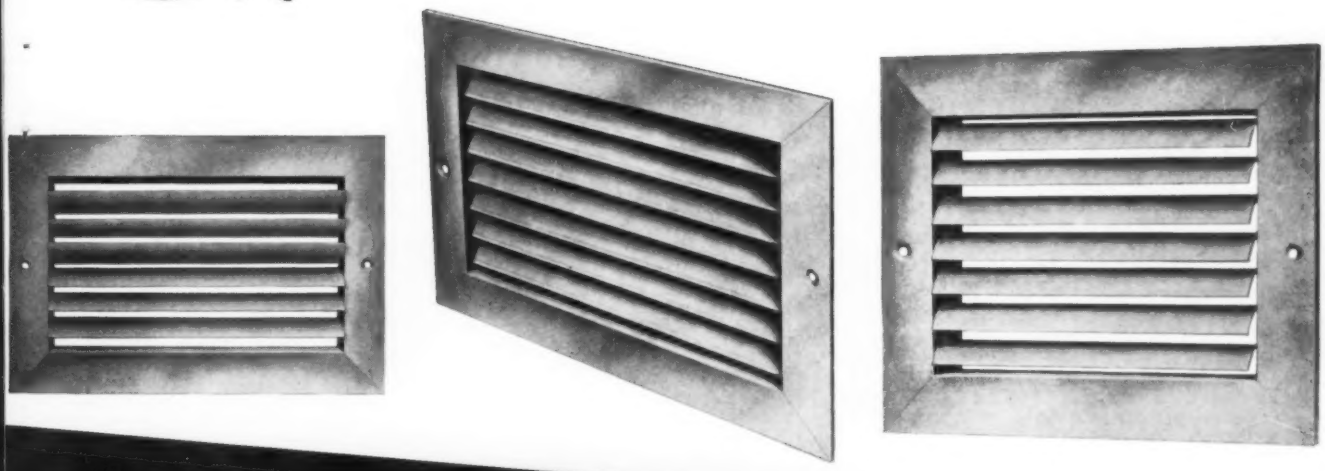

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**STRONG** Tuttle & Bailey STANDARDLINE grilles and registers have *all* parts of extruded aluminum . . . far stronger than rolled aluminum and impervious to rusting, pitting, corrosion . . . even in salt air. You can count on STANDARDLINE units to retain a "just-installed" appearance.

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## TUTTLE & BAILEY

Division of Allied Thermal Corporation
New Britain, Connecticut
Tuttle & Bailey Pacific, Inc., City of Industry, Calif.

# Why a Steam Trap Has to Handle "Air"

## Low temperatures and corrosion of equipment are often evidence of inadequate trap air venting capacity

Air, with its load of oxygen and carbon dioxide, has an unwholesome habit of interfering with the efficiency of steam heated units. If steam were always free of these undesirable companions, things would be a lot simpler for men-who-operate-plants. Because it isn't, three unhappy situations frequently occur:

1. ***Operating temperatures are subnormal.*** This is a two-part problem. First, an air-steam mixture has a lower temperature than pure steam at the same pressure—see Table A. Secondly, air can "plate out" on heat transfer surfaces as shown in Figure 1. Under some conditions, such an air film will knock down heat transfer efficiency by as much as 50%.

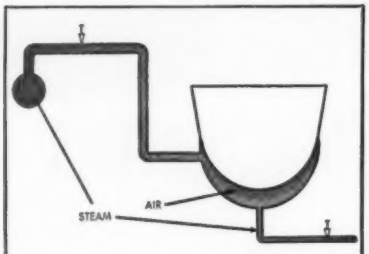



Fig. 1. *How air can "plate out" on heat transfer surfaces. This "insulation" drastically reduces heat transfer efficiency. Armstrong trap operation creates turbulence in the equipment that prevents this.*

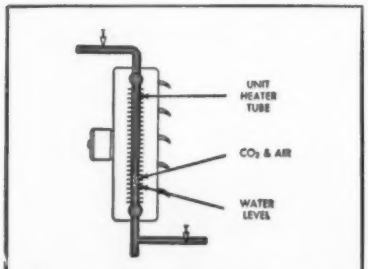



Fig. 2. *Corrosion occurs when units are not kept continuously free of both condensate and air. Armstrong traps discharge both,* at steam temperature, *as fast as they accumulate.*

2. ***Corrosion rears its ugly head.*** Oxygen and carbon dioxide are real trouble-makers. $CO_2$ gas goes into solution in condensate, forms carbonic acid and chews away at vulnerable metal sections. $O_2$ aggravates the situation. See Figure 2.

**TABLE A—How air reduces steam temperature.**

| Gauge Pressure | Temp. of Steam with No Air Present | Temp. of Steam Mixed With Various Amounts of Air (% Air by Volume) | |
|---|---|---|---|
| | | 10% | 30% |
| 10.3 | 240.1 | 234.3 | 220.9 |
| 25.3 | 267.3 | 261.0 | 246.4 |
| 50.3 | 298.0 | 291.0 | 275.1 |
| 75.3 | 320.3 | 312.9 | 295.9 |
| 100.3 | 338.1 | 330.3 | 312.4 |

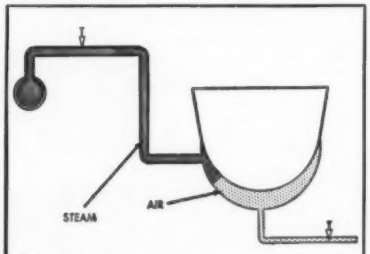



Fig. 3. *When steam is turned on, it takes a trap with extra air venting capacity to provide fast heat-up.*

3. ***Heat-up is slow as a snail.*** Air has a picnic in units that are shut off periodically. Figure 3 pictures the problem. Lines and equipment literally fill up with air. When the steam is turned on it can get in only as fast as the air gets out.

### Enter Steam Traps

Curing these steam system ailments involves an operation sometimes called a "trap transplant." It consists of removing traps that don't get the air out and replacing them with traps that do.

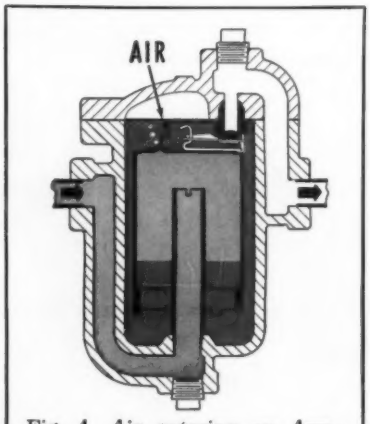
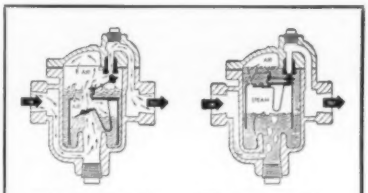



Fig. 4. *Air entering an Armstrong trap passes through the bucket vent and accumulates in the top of trap. When trap opens, air is discharged along with condensate.*

Figure 4 shows how an Armstrong inverted bucket trap continuously vents air. What the picture doesn't show is a built-in plus-value of this trap's design. An Armstrong trap opens suddenly, creating a momentary pressure drop and turbulence in the unit being drained. This breaks up air films and "pumps" air down to the trap so it can be vented.

The vents in standard Armstrong trap buckets will pass all the air normally encountered. In special cases, such as paper machine dryers, the vents are correctly sized larger at the factory to meet the requirement.



*Thermostatic vent open.* *Thermostatic vent closed.*

Fig. 5. *Open float with thermostatic vent for off-and-on units. When trap is cold, vent is open, permitting air to blow through when steam is turned on. When steam reaches trap, heat closes thermostatic vent. Then, regular bucket vent handles all air coming in with steam.*

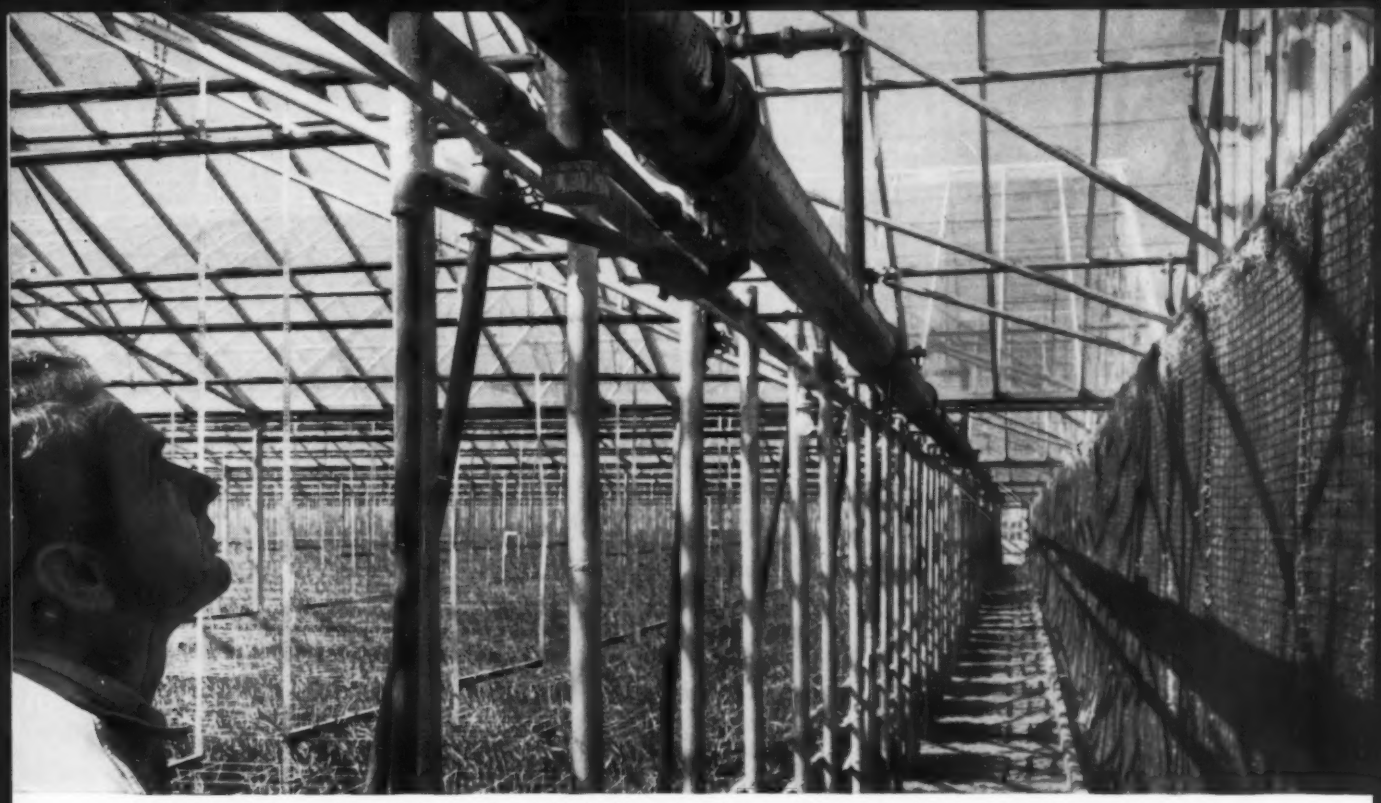
### Open Float with Thermostatic Vent

Super air-venting capacity is a must for fast heat-up of low pressure unit heaters, heating coils, steam headers and other units that are on-and-off. Figure 5 shows how the Armstrong open-float-with-thermostatic-vent trap takes care of this.

* * *

The 44-page Armstrong steam trap book covers other features of the Armstrong trap as well as its excellent air handling characteristics. This catalog also discusses trap selection, installation and maintenance. Your local Armstrong Representative or Distributor will be glad to give you a copy. Call him, or write Armstrong Machine Works, 8748 Maple Street, Three Rivers, Michigan.

**ARMSTRONG STEAM TRAPS**



Rapid outside temperature variations require reliable heating systems to protect delicate carnation plants. Here, a six-inch main line feeds off to two-inch feed lines. Over 34,000 ft of Spang Steel Pipe was used to provide overhead heating in four Denver greenhouses.

# SPANG Steel Pipe installed in new type heating system at 4 Denver greenhouses

Until recently, greenhouse heating pipes were usually installed under growing benches. Flower growers believed that maximum root action could be obtained through alternately sprinkling the soil and drying it with heat from the pipes.

Today, in Denver, this has changed. In four new greenhouses in the Denver area, controlled air moisture provides just the right humidity throughout the greenhouse. And SPANG Steel Pipe has been installed *over* the growing areas to provide uniform steam-heat temperatures the year around.

## Denver weather creates heat control problems

Raymond Petty, co-owner, Petty Greenhouse Construction Company, Denver, reports: "About 90% of greenhouse production here is in carnations, and these plants are very susceptible to cold weather. We get rapid temperature variations, and it takes an efficient and dependable heating system to protect the high investment in plants. We must guarantee a 50°F inside temperature at minus 10°F outside.

"We know with SPANG we have a good, uniform, reliable pipe in the heating systems. The pipe arrived in excellent condition—no burrs or interior obstructions, no holes or leaks at the threaded joints. It has excellent welding characteristics. We installed about 34,000 ft of SPANG in the four greenhouses, and we expect it to give at least 20 years of service."

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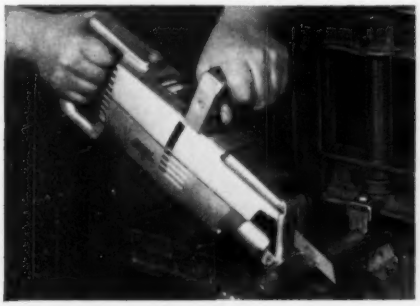
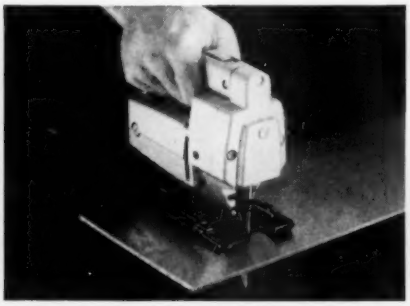


**NEW IDEA—electric hacksaw!** New Skil Model 701 Recipro Saw cuts 1" solid steel bar in 23 seconds! Has 2-speeds—low for stainless, other hard alloys, cast iron; high for mild steels, non-ferrous metals. Complete with case. **$124.50**



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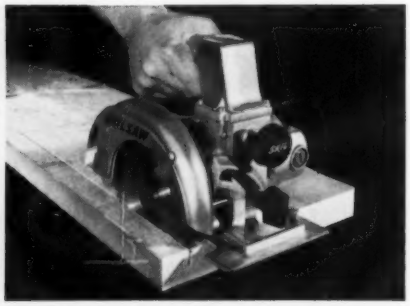

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VIRGINIA Chemicals

# REFRIGERATION BULLETIN

*Facts about water system maintenance*

# TIPS ON CLEANING TOWERS AND EVAPORATIVE CONDENSERS

Costly emergency repairs during a busy season can be prevented by proper application of water chemicals at startup and shutdown time. Two basic steps are important. First, remove all dirt, scale and algae; second, retard corrosion and recurrence of scale with "Virginia" Corrosion Inhibitor. Follow a specific program to prolong equipment life and maintain maximum operating efficiency.

## Cleaning Procedure

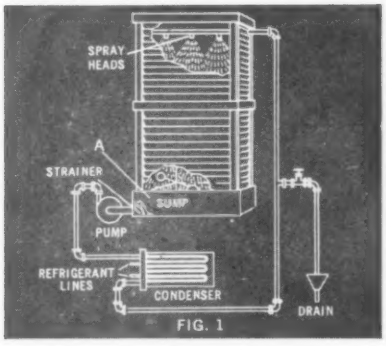

FIG. 1

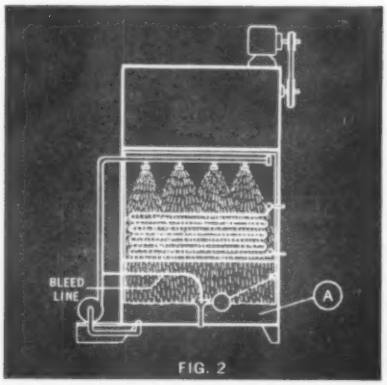

FIG. 2

(1) Drain and flush out loose dirt from sump. This consumes and wastes cleaner. *This is important.*

(2) Close bleed and refill with fresh water.

(3) Estimate gallons of water in the system. Then add first dosage of solid or liquid scale remover as follows:

"Virginia" Scale Remover—Solid . . . 5 lb. per 10 gal. water

"Virginia" Scale Remover—Liquid . . . 1 gal. per 15 gal. water

In natural draft cooling towers and in evaporative condensers, the chemical can be added at the sump (as in Figs. 1 & 2). In forced draft towers it can be added at the tower distribution plate, tank or sump.

(4) Operate system as usual. Check the scale remover solution strength in the sump every 10-15 min. with test papers. If paper does not turn *red* when immersed, add more cleaner until it does. Lowered head pressure will indicate when unit is clean—or simply inspect the tubes of the evaporative condenser. Inspecting the water outlet pipe of shell and tube condensers will tell you the scale condition of this type of unit.

(5) After scale removal, drain the solution into the sewer. Rinse the system twice with fresh water.

## Scale Prevention

Following the cleaning procedure, apply "Virginia" Scale & Corrosion Inhibitor in the following steps:

(1) Adjust bleed rate according to table below.

(2) Use 2 lb. Inhibitor per 10 tons' capacity for soft water. Triple this amount for hard water. Use a shallow wire mesh basket for crystals. Place in the sump.

(3) Repeat ⅔ of this dosage after a 90-day period.

| Make-up water hardness (parts per million) | 100-199 | 200-299 | 300-up |
|---|---|---|---|
| Bleed rate in gal. per hr. per 10 tons | 9 | 18 | 36 |

## How to clean shell and tube—coil condensers

Isolate the condenser from the cooling tower by valves or by actually disconnecting its piping. Prepare a strong cleaner solution in a large plastic pail or wooden tub. Dissolve 5 lb. of solid scale remover in 10 gal. of water—or add 1 gal. of liquid cleaner to 15 gal. of water. Circulate this solution through the condenser by using a pump, as in Fig. 3. Cleaning moderately scaled units should take about one hour. Test the solution regularly with test papers. Add more cleaner as needed. After cleaning, empty and flush the condenser at least twice and then replace it in the system.

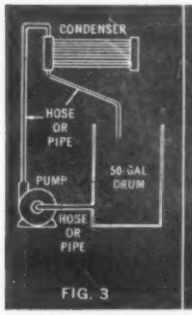

FIG. 3

FIG. 4

To open up condensers completely clogged with scale, use standpipes (see Fig. 4). Mix liquid cleaner and water in equal proportions. Fill the pipes to a level above the condenser. Protect surrounding objects from being injured by any foaming that may occur. After cleaning, drain the spent solution. Rinse condenser twice with fresh water.

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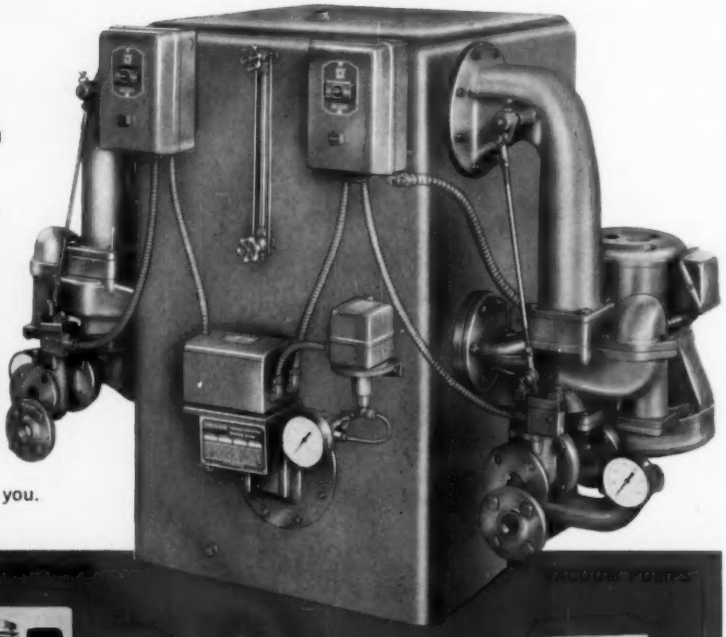

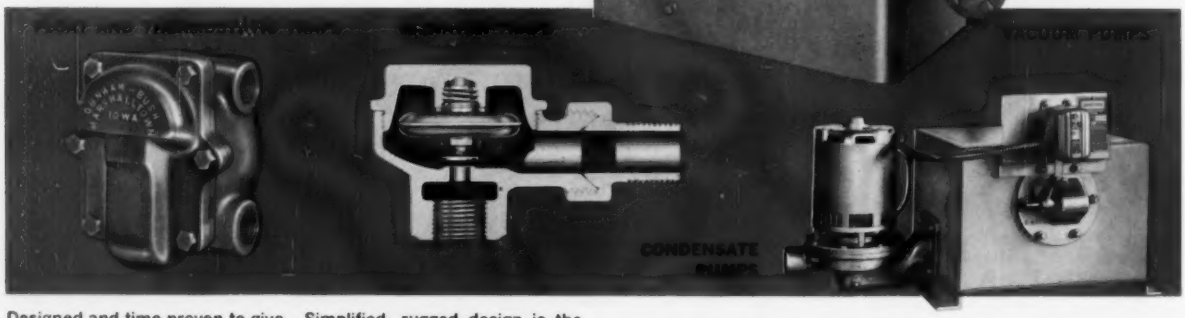


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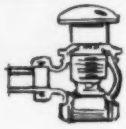

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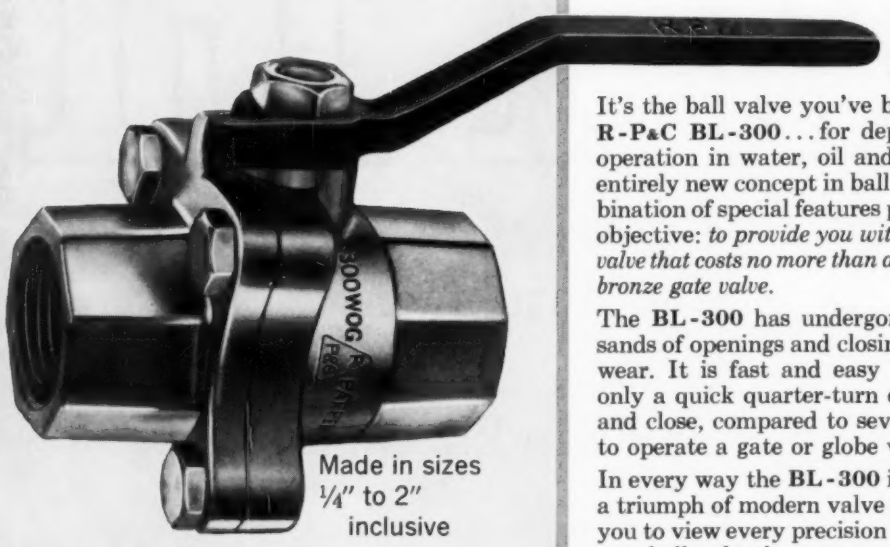


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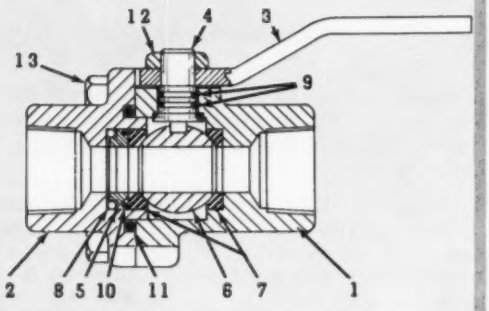


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- The **BL-300** has "auto-mating" seats to assure positive sealing in either flow direction, making it ideal for vacuum service.
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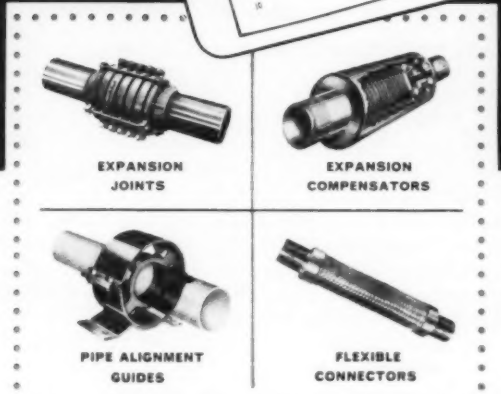


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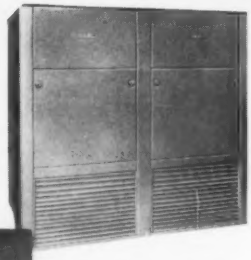
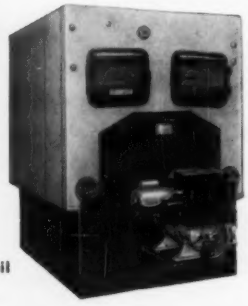


Type J Gas Boiler

No. 82 Oil Boiler



ICH-ICL Combination Oil and Gas Boiler

Weil-McLain makes a complete line of cast iron sectional boilers for all fuels. While the Company believes that its products today represent top engineering, it also realizes that designs and materials considered as sound today will not necessarily be adequate tomorrow.

The Weil-McLain Research and Engineering Laboratory is evidence of the Company's belief that only through constant study and flexibility of thinking can it continue to hold its position as a manufacturer of highest quality boilers and radiation. Here research and experiment are translated into better product...so that Weil-McLain equipment can always be installed with complete confidence.

Practical field help is also provided. Questions relating to proper system design, product selection, installation and servicing of Weil-McLain heating equipment are handled promptly by the Technical Services Department. In the Weil-McLain School of Better Heating, classes in the design and installation of modern hydronic heating systems are regularly conducted for contractors and wholesalers.

*Send for condensed catalog of Weil-McLain Commercial and Industrial Boilers*

WEIL-McLAIN
BOILERS · RADIATORS

**WEIL-McLAIN COMPANY**
Incorporated
**MICHIGAN CITY, INDIANA**

**Address literature requests to Dept. AA-71**

# Low Water Cut-offs on Hot Water Boilers?

## ...the industry has given the answer

Yes, the answer has come from the field . . . from the engineers, contractors and manufacturers. They have seen the logic of installing a water level control on hot water space heating boilers . . . a low water cut-off, or—for even greater precaution—a feeder cut-off combination.

We knew it was a good idea. Expected it to grow and grow. But frankly we have been surprised at how rapidly the heating industry has taken hold of water level control as a logical team mate for an ASME pressure relief valve.

In fact, many local codes now require a low water cut-off, or feeder cut-off combination, on hot water boilers installed in places of public occupancy—including multiple dwelling units.

Notice the diagrams of recommended installations opposite. For more detailed discussion get this booklet that tells the whole story: "Basic Safety Controls for Hot Water Space Heating Boilers."

***The What-Why-How in eight interesting pages***

Write for Bulletin P-30C

Your Jobber Stocks McDONNELL Products

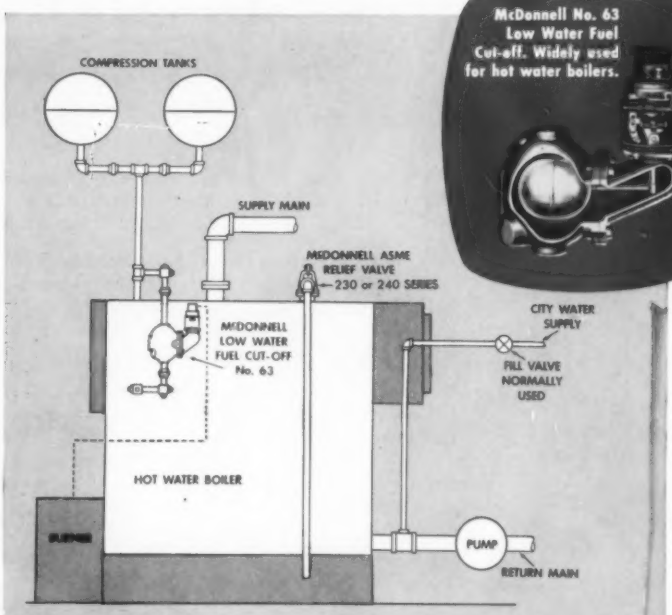
**McDONNELL & MILLER, *Inc.***

**3500 N. Spaulding Ave., Chicago 18, Ill.**

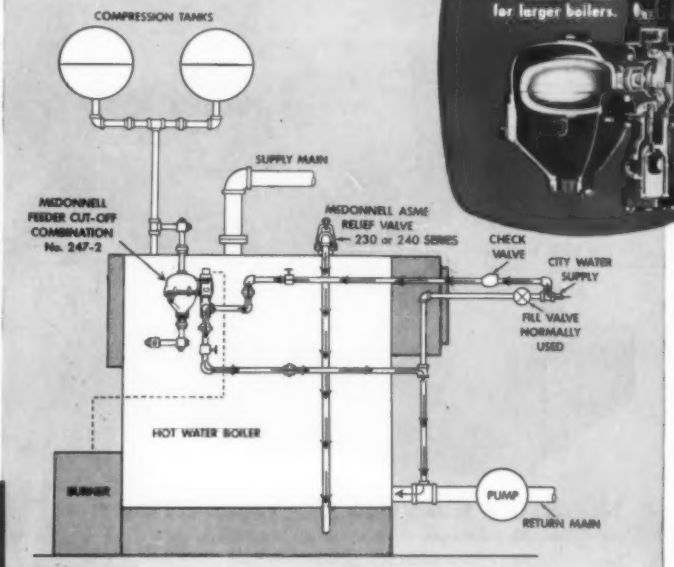
*Doing One Thing Well*

# McDONNELL

*Boiler Water Level Controls*




**1** The essential low water control for a hot water boiler. A McDonnell Low Water Cut-off located above lowest permissable water level; also McDonnell A.S.M.E. Pressure Relief Valve.




**2** The safest and most complete control for a hot water boiler. Offers a combination of mechanical and electrical safeguards which is today's best and most complete answer. A McDonnell combination Boiler Water Feeder and Low Water Cut-off; also McDonnell A.S.M.E. Pressure Relief Valve.

WAGNER® MOTORS AT WORK

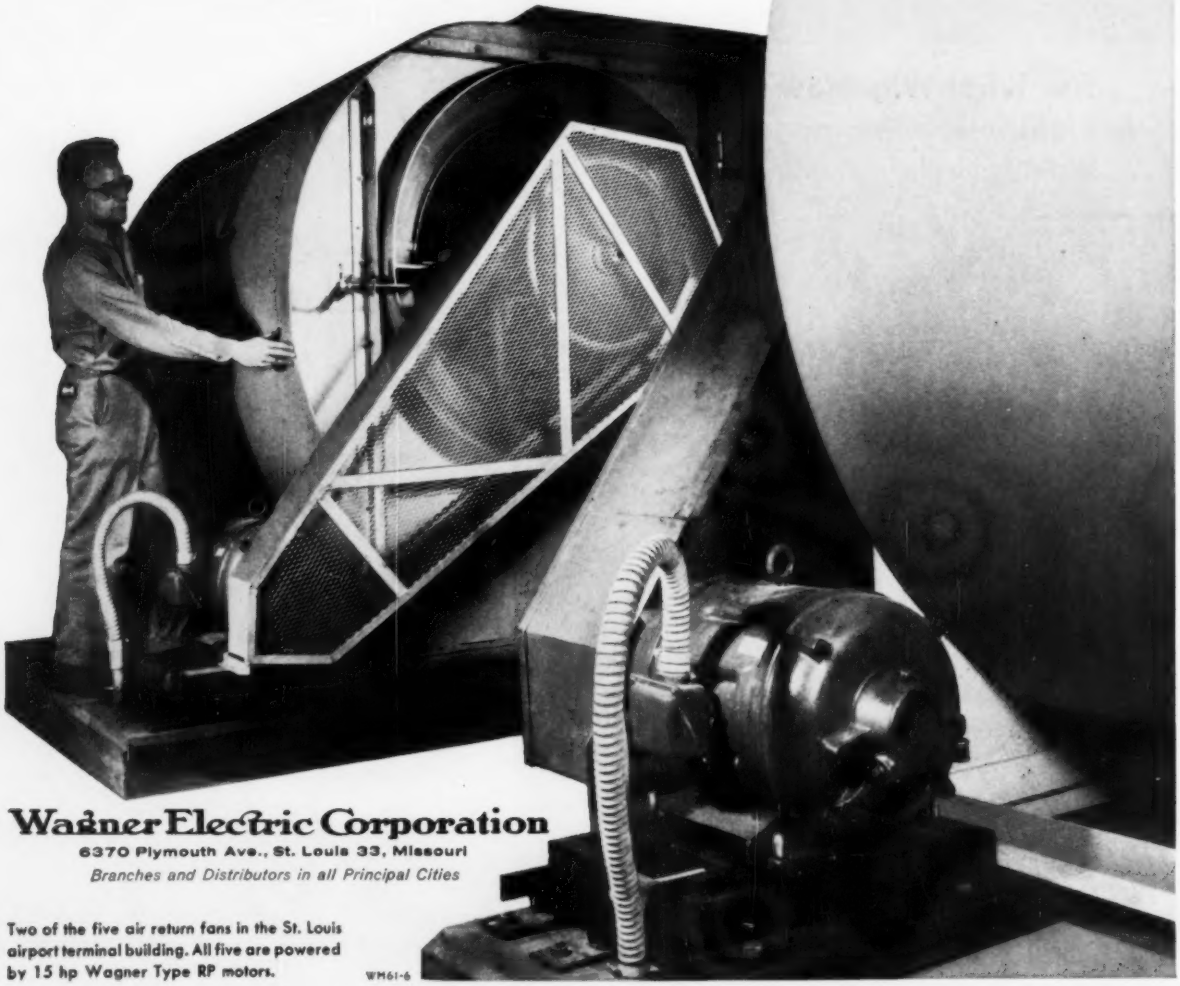
# power to ventilate an air terminal

## Quiet Wagner® polyphase motors drive air moving equipment at St. Louis' jet age airport

Keeping any building warm in winter and cool in summer is a demanding job. It's a demanding, king-size job in the 50,000 square foot Municipal Airport terminal in St. Louis.

Air movement in this architecturally renowned building is handled by five air supply fans and five air return fans. They're all driven quietly and dependably by Wagner* Type RP motors . . . five 40 hp motors for the air supply fans, and five 15 hp motors for the air return fans.

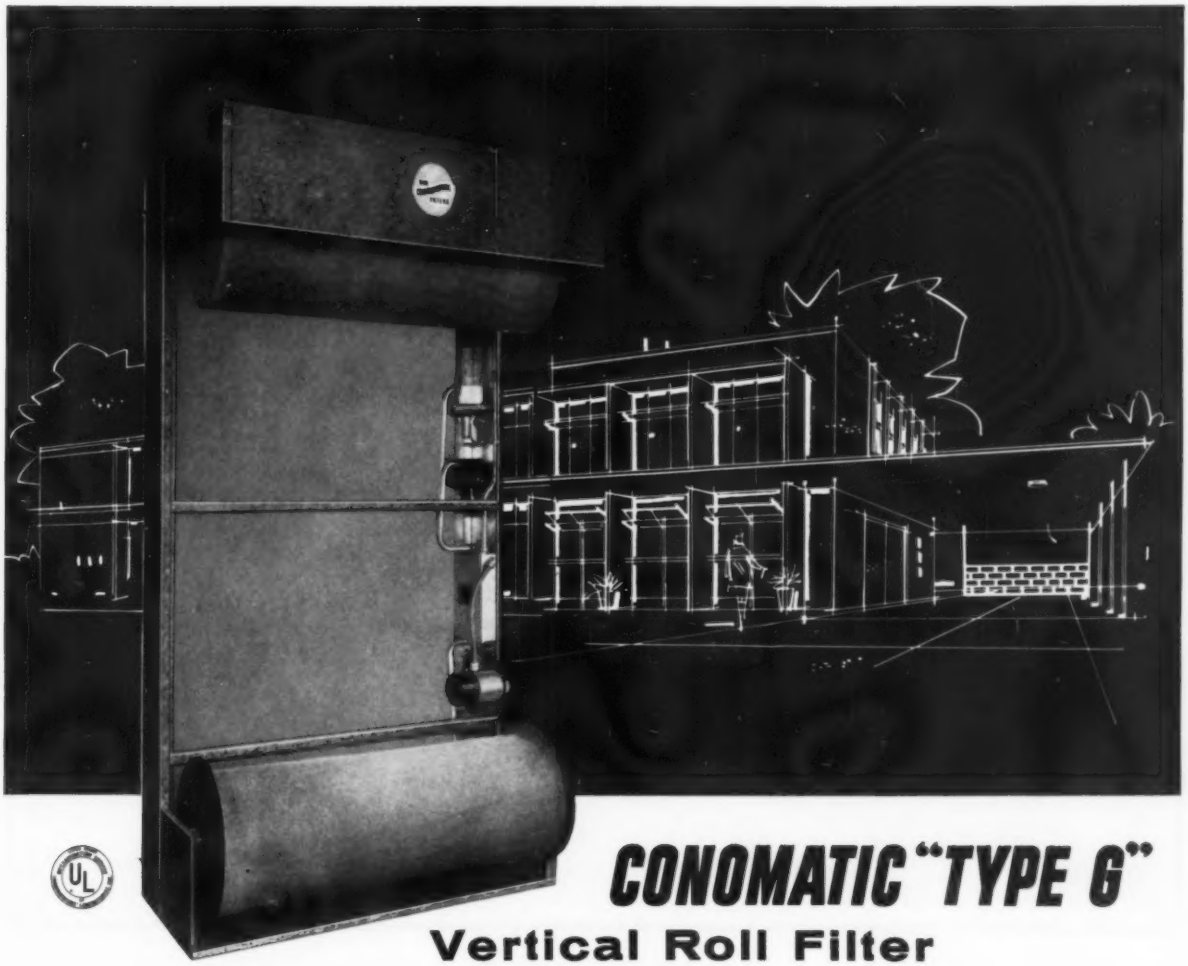
These open type polyphase squirrel-cage motors have the stamina to be perfect drives for fans, pumps, blowers and compressors. They operate for long periods without maintenance . . . efficiently produce power even under critical conditions. Compact and dripproof, they get the job done at St. Louis' jet age airport and in millions of other applications across the country. They can do a job for you. Your Wagner Sales Engineer will be glad to show you how. Call him. Soon.



**Wagner Electric Corporation**
6370 Plymouth Ave., St. Louis 33, Missouri
*Branches and Distributors in all Principal Cities*

Two of the five air return fans in the St. Louis airport terminal building. All five are powered by 15 hp Wagner Type RP motors.

WM61-6



# CONOMATIC "TYPE G"

## Vertical Roll Filter

*Now your entire air system can be automatic!*

Continental's CONOMATIC vertical roll-type air filter assures you that your equipment will *continue* to perform properly. Fully automatic in maintaining filtering efficiency, the CONOMATIC keeps your air system at a "good-as-new" operating peak.

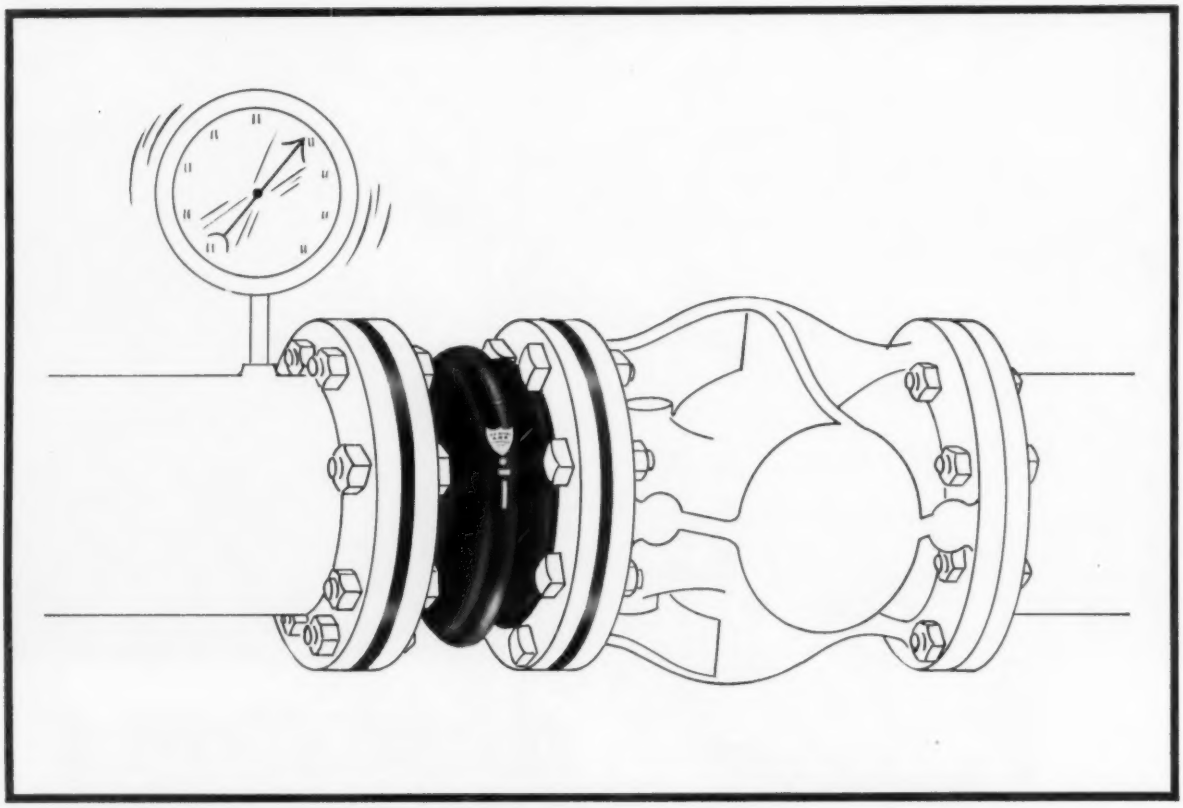
You *save* with CONOMATIC—in time, in money—because the unit is factory-assembled for fast and lowest-cost installation. And virtually no maintenance is required. Specify this fully automatic vertical-type roll filter! For complete facts, ask your Continental Agent, or write to us at P. O. Box 1647, Louisville 1, Ky., for Bulletin 819a.

*Clean Air Costs Less with Continental!*

- Matches the job. Available in any size needed.
- Capacities from 5,240 cfm up.
- Access from the entering-air side for all servicing.
- "Ready-to-run" when delivered to you. Completely assembled. Completely wired.
- Underwriters Listed—for safety, for quality.
- Galvanized or cadmium-plated throughout.
- Totally-enclosed drive motor, with built-in overload protection.
- Non-reversing air flow through media—eliminates dirt "blow-off"!
- Control choices: either timers or pressure switches.
- CONOMATIC Horizontal "Type GH" also available.

CAF CONTINENTAL AIR FILTERS, INC.
LOUISVILLE 1, KENTUCKY

U.S. EXPANSION JOINTS



# U.S. AMR Expansion Joints

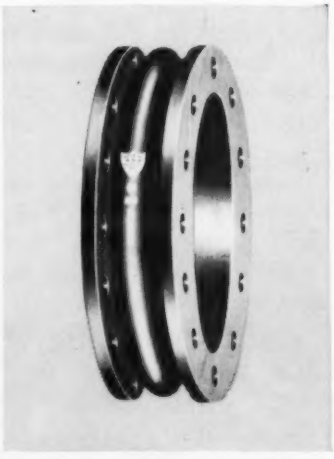
## handle even the highest surge pressures safely

Today's power and processing systems require piping that withstands flow surges, high pressures, and high temperatures unheard of a few years ago. Going hand in hand with improved piping is the simultaneous demand for better expansion joints.

U. S. Rubber . . . the company that brought you the *first* rubber expansion joint . . . now brings you the new AMR expansion joint, designed to meet today's most rigid requirements.

The AMR Expansion Joint:

- Has a new, patented inner construction with built-in *surge* protection for increased service life.
- Withstands higher continuous working pressures—pressures that exceed even the capacity of conventional wire-armored expansion joints.
- Has the flexibility of standard joints.
- Is available now in materials for handling corrosive chemicals and/or wide temperature ranges.



Your "U. S." representative will call at your request to give you the full facts and samples of this revolutionary development in rubber expansion joints. Why not call him . . . or write US at Rockefeller Center, New York 20, New York.

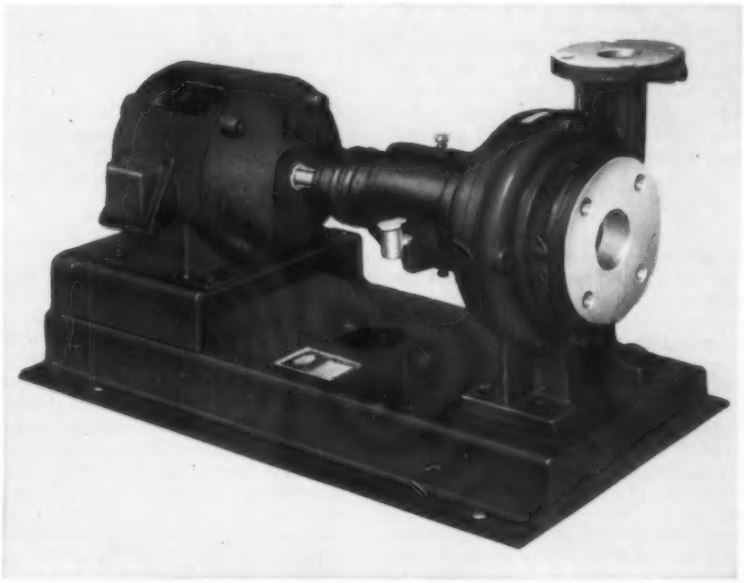
WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

**United States Rubber**

MECHANICAL GOODS DIVISION

# prove it to yourself!

## ...THAT THE SERIES 1510-B CENTRIFUGAL PUMP OFFERS MORE



### 1510-B FEATURES

- Vertical split case design—solid-type volute can be left in pipe line when servicing pump.
- Removable bearing frame assembly—can be lifted out without disturbing piping or motor leads.
- Interchangeable bearing frame assembly—one unit fits a wide range of pump sizes.
- Positive oil lubrication with visual check.
- Anti-friction *roller bearings.*
- Mechanically balanced impeller. Balancing chamber and pressure relief holes in impeller reduce thrust to a minimum—lengthen pump life.
- Leak-proof "Remite" seal. Carbon seal ring faces on harder-than-glass Remite floating seat. Assures long, trouble-free life.
- Special alloy steel shafts, superfinished, oversized.
- Performance guaranteed—100% pre-tested at the factory for conditions of head and capacity specified.
- Choice of all-iron, bronze-fitted, or all bronze.
- Capacities to 2000 GPM, heads to 420 ft.

**Why not get your full dollar's worth of pump value...send today for selection data on the B&G 1510-B Centrifugal Pumps.**

**Check any centrifugal pump of comparable capacities against B&G 1510-B Pump features!**

B&G Series 1510-B Centrifugal Pumps are distinguished by all the features listed at left. To compare any other pump with the 1510-B, place check marks in the red boxes beside the features also offered by the competitive pump.

*We'll wager you'll wind up with quite a number of unchecked boxes!*

The balanced design of this *vertical split case* pump is definite assurance of smoother, more efficient performance and longer life. Its design enables the bearings to withstand loads far in excess of those produced by any pump and motor combination in the 1510-B series ...an added feature of dependability.

**NOW AVAILABLE IN "C" SIZE UNITS UP TO 75 H.P.**
2000 GPM, 170 feet, 1750 RPM,
3"—4"—6"—8" discharge connections

**BELL & GOSSETT COMPANY**
Dept. G5-5, Morton Grove, Illinois

*Canadian Licensee: S. A. Armstrong, Ltd., 1400 O'Connor Drive, Toronto 16, Ontario*

# High Temperature Water vs. Steam
## *for space heat, process heat, air conditioning*

C-E makes *both* types of equipment. Here are the facts:

High temperature water systems are coming into wider use — not only for space heat and process heat applications, but for use with absorption air conditioning equipment as well. Customers have ordered some 80 High Temperature Water Boilers (Type HCC) for these purposes, with plant capacities ranging from 10 million to 300 million Btu/hr, and operating at water pressures up to 500 psi and temperatures to 470F, or higher.

### The "Thermal Flywheel"

With a steam system, boilers often have to be operated constantly at full load. Wide load swings can cause loss of steam pressure and considerable lag before sufficient steam can be supplied. But because a high temperature water system has a far greater heat storage capacity than a steam system at the same pressure, even sudden large demands will not drain heat from consuming units. Thus fluctuating demand does not immediately affect boiler loads. Boilers operate at a more constant rate which improves the efficiency of the entire system. In industrial applications, temperature of ovens, tanks, calender rolls, heating platens, etc., can be controlled within close limits, which often results in improved product quality and increased production.

### Savings with High Temperature Water

While capital costs for steam generators and high temperature water boilers of equivalent capacity are roughly the same, a system using a C-E Hot Water Boiler can usually save from 10 to 20 percent in operating and maintenance costs:

**1. No steam traps.** This means substantial savings in initial cost, plus further savings by eliminating trap maintenance. Steam losses due to normal trap operation are also eliminated;

**2. No blowdown required.** This represents a considerable loss in steam systems, reflected in increased fuel costs;

**3. No pressure reducing valves.** Initial valve cost is reduced and losses from improper valve regulation are prevented;

**4. No pipe grading required.** The system is always under pump pressure. Piping can be carried over machinery, in roof trusses, up or down grades — even underground. Pipe life expectancy is increased many times since corrosion is minimized in a closed oxygen-free system;

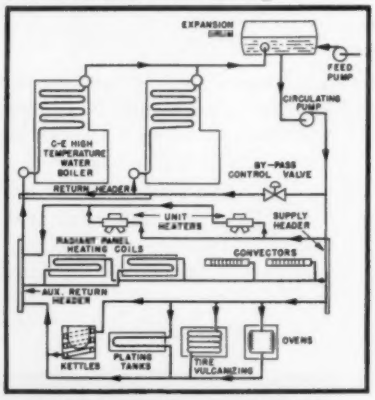
**5. No condensate return lines.** And no investment outlays for corrosion prevention; cost of replacing wet returns is eliminated;

**6. No expensive feedwater treatment.** Since only small quantities of make-up water are needed, treatment can be handled on a batch system basis.

### Versatility of High Temperature Water

For heating units such as space heaters, radiant panels, etc., high temperature water may be used directly. For domestic heaters, ovens, tanks, vulcanizing equipment, etc., it can be used indirectly — as low temperature hot water or as steam — produced in suitable heat exchangers.

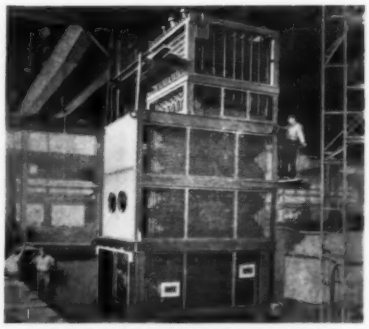
In addition, high temperature water is well-adapted to use in the coils of absorption refrigeration units — for cooling, as well as heating, multi-building applications. Absorption equipment can be located in each building and can operate without the supervision of licensed engineers, at a considerable labor saving.




A simplified schematic arrangement of typical high temperature water applications in industrial or commercial plants. Shown are the Type HCC boiler, expansion tank, circulating pump and actual heat consuming units. Heat exchangers for conversion to low pressure hot water are also used frequently in these systems.

### The C-E High Temperature Water Boiler

C-E High Temperature Water Boilers are designed around the same controlled circulation principle used by C-E in many of the world's largest steam generation units. They can be fired by oil, gas, coal or any combination of these fuels. They operate with low pressure loss, provide complete control of system and boiler circulation, and offer optimum arrangement of heating surfaces. All circuits are drainable and headers are accessible from outside the boiler casing. With no baffles in the boiler, there are no areas where soot can accumulate. Symmetrical arrangement of heating surfaces permits a rugged, gas-tight casing construction which can be pressure fired and is entirely suitable for outdoor installations.



A 30 million Btu Type HCC boiler partially shop assembled, showing compactness of the unit. Upon addition of refractory and welded casing, boiler will be lifted by its lugs onto a flat car for shipment.

The standardized design of these units results in lower first cost, shorter delivery time, lower cost of ownership. Smaller sizes are completely shop assembled, while larger sizes are shipped in component assemblies, to reduce field erection costs.

### You be the Judge

Because most operators, engineers and contractors are more familiar with steam than with hot water systems, we have gone to some length to enumerate the major differences between the types. Naturally, needs vary, and the eventual choice of a heating system should be made only after a thorough investigation of all factors.

Our engineers will be pleased to discuss either hot water or steam units, or both, with you and your consultants — impartially and with no obligation. For further details on high temperature water boilers, write for catalog HCC-2.

**COMBUSTION ENGINEERING** C-E

C-321

General Offices: Windsor, Conn.
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200 Madison Avenue, New York 16, N. Y.
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ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

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## C.E.C. Meets in Chicago, Plans Action On Registration Laws and Alleged Government Encroachments

RESTRICTING THE PRACTICE of engineering to licensed engineers, maintaining the private enterprise system, and raising the standards of engineering practice — these were among the more important topics discussed recently at the Consulting Engineers Council Board of Directors Fifth Annual Meeting held in Chicago. Cramming more than 65 subjects into three days of deliberations, the C.E.C. Board took significant action on a variety of problems and programs pertinent to the consulting profession.

### Registration Laws

Plans for continued action to strengthen state registration laws, particularly as applied to corporate practice, were reported as deserving of intensive C.E.C. consideration. Legislation has been enacted in the state of Washington to permit corporations to "practice" engineering as long as the seal of a registered professional engineer is on all plans and specifications produced by the corporation. In Ohio and Michigan, recent judicial rulings have declared that those states' engineer registration laws are ambiguous and unconstitutional.

C.E.C. holds the viewpoint that corporate practice is permissible only so long as the majority of the owners, principals, officers and/or stockholders of the corporation are registered and responsible, as such, for engineering services which the corporation provides. A

CONSULTING ENGINEER COUNCIL officers elected recently in Chicago are shown plotting the Council's program for the coming year. Left to right are: George J. Toman, secretary; Hueston M. Smith, immediate past president; Harold P. King, president; Cedric R. Acheson, first vice president; George W. Poulsen, Jr., treasurer; and Sanford K. Fosholt, second vice president

you'll want to know

program to enlist support within the National Council of State Boards of Engineering Examiners for this point of view was reported as making headway.

As for the Ohio-Michigan court rulings, engineer groups in both states are said to be preparing amended versions of the law for consideration by their legislatures.

**Competitive Bidding**

The C.E.C. Board warned all Council members of the possible legal consequences of rejecting bid requests. While strongly opposed to competitive bidding, the

*Continued on page* 207

## New York State Opens Air Pollution Control Library

A COMPREHENSIVE technical library specializing in air pollution control and an audio-visual service are now available to scientists, educators, and engineers in New York State, Dr. Herman E. Hilleboe, State Health Commissioner and Chairman of the New York State Air Pollution Control Board, has announced.

The technical library contains more than 8000 microfilmed books, articles, and scientific papers ranging from an air pollution control publication printed in 1661, to instruction books for operating giant electrostatic smoke precipitators. Frequently used reference works in their original printed form have also been collected.

Located in the State Health Department Building at 84 Holland Ave., Albany, the library is equipped to provide space, microfilm readers, and other necessary supplies to researchers.

Filmstrips, motion pictures, more than 1000 photographs and approximately 800 color slides of air pollution sources, problems, and controls are available for teaching purposes, to illustrate lectures and publications, and for civic group programs.

Library privileges and the loan of materials from audio-visual service can be arranged by contacting the New York State Air Pollution Control Board, 84 Holland Ave., Albany 8.

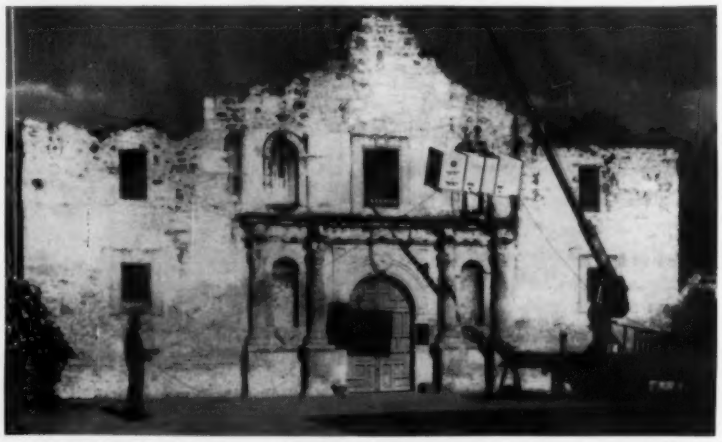
# Texans Air Condition the Alamo

AFTER almost 250 years, the famous Texas Alamo has finally been air conditioned. The structure was built by Franciscan missionaries about 1722, and gained its fame when Davy Crockett, Jim Bowie, and other men managed to delay Mexican forces in 1836 during the Texas-Mexican war.

Engineers planning the year 'round air conditioning installation faced many problems: how to install air conditioning apparatus so it would not add a jarring modern note to the Alamo's rough-hewn interior; how to comfortably heat and cool the high-ceiling building in Texas temperatures with a 100 F span; and how to furnish adequate capacity to cope with the many-feet-thick walls which soak up heat and could not be insulated.

Three heat pumps were installed in concealed locations, according to the General Electric Co. A pair of 4 ton units were placed on the Alamo's roof behind a parapet. Immediately below the units, workmen opened a pair of musty choir lofts last used prior to 1793 when the Alamo, originally a church, was secularized. Supply outlets extend through these lofts, aimed at the main room of the structure. Heavy iron window grilles typical of 18th century Spanish churches were used to camouflage the outlets.

The other heat pump was installed in a small stockade made of cedar posts. This structure is topped by a weathered thatch roof.



**HEAT PUMP** is hoisted up to be placed behind parapet. In all, three units were used to air condition the Texas monument

# Radiant System Heats $2½ Million Sports Center

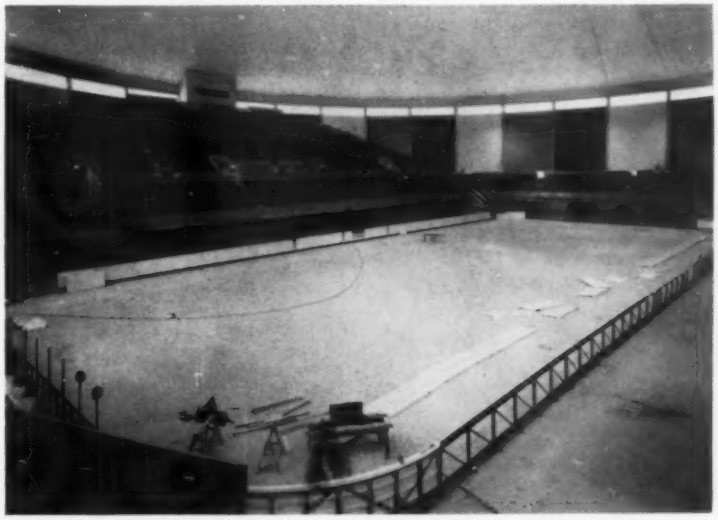
AMATEUR HOCKEY FANS in Montreal can look forward to viewing their sport in warm comfort at the city's new $2½ million sports center. A radiant heating system has been installed under all seats in the 5000 capacity arena, and also in the sections adjacent to the ice rink.

One in. diameter wrought iron pipe specified for the system was fabricated into sinuous coils, laid on 6 in. centers in the spectators' section, and then encased in 2 in. of concrete. Coils along side the rink were spaced on 6 in. centers and covered with 2 in. of concrete with terrazzo surface according to the A. M. Byers Co.

The heating system is divided into two heating zones, each having its own converter and control. A steam boiler plant will provide 2700 lb of steam per hr to heat water for the system to 110 F. The heat exchanger will provide 250,000 Btu per hr. Each circulator will provide 125 gpm against 20 ft heads.

LeBlanc & Montpetit designed the radiant heating system and also the ice rink. The heating contractor was Doucet & Doucet.

RADIANT HEATING COILS seen in stands make Montreal's new sports center one of the few in the world to use this type of heating



FINAL TOUCHES have been given to the arena. The wrought iron radiant heating coils have been covered with 2 in. of concrete

## Natural Gas Engines Found Reliable for Air Conditioning

MORE THAN 12,000 HOURS of operation have failed to damage significantly two natural gas engines that have been used to drive reciprocating compressors in the air conditioning system for the Ohio Fuel Gas Co.'s Long Street Building in Columbus, Ohio. This is equivalent to approximately 450,000 to 500,000 miles of operation of an engine driven vehicle.

Prior to the start of the 1960 air conditioning season, these 137 bhp engines were subjected to a tear down inspection. Only very slight signs of wear were found. The major damage uncovered was two exhaust valves burned on one of the engines.

The performance of these engines through their first two years of operation (1956-1957) were reported in the article "Installations Show How Gas Engines Drive Air Conditioning Systems" by R. S. Curl and R. C. Marsh of Robert S. Curl and Associates, consulting engineers, which was published in

## you'll want to know

the September 1958 issue of HPAC. According to Mr. Marsh, the authors feel that this experience is an excellent indication of the reliability of natural gas engines for this application.

Tabulated data given in the 1958 article provides detailed operating cost data for the engine driven installation. For the 1957 season, operating costs (engine driven condensing unit only, including gas and oil) was approximately 0.75 cents per ton-hr. Maintenance was less than the $227 allowed in the initial operating cost estimates for the system. The Long St. system has a design cooling load of 184 tons of refrigeration.

## W. T. Miller Award Goes to Carl Grinstead

CARL E. GRINSTEAD, senior in mechanical engineering at Purdue University, received the W. T. Miller award at the annual meeting of the Central Indiana Chapter of the American Society of Heating, Refrigerating and Air-Conditioning Engineers at Indianapolis.

The award was established in 1956 to honor Professor Emeritus Miller of the Purdue staff, long time leader in the field of heating and air conditioning. The recipient is selected by a committee of the Indiana chapter and is based on the activity points of the members of the student branch. The award consists of a collection of approximately 15 of the best books in the field of heating, air conditioning, and refrigeration. In addition, Mr. Grinstead will have his name inscribed on a permanent plaque which hangs in the Mechanical Engineering building.

John P. Kamman and George R. Rawlinson also received awards consisting of books in this field of engineering.

**A COLLECTION of books on heating, air conditioning, and refrigeration has been awarded to three Purdue University seniors by the Central Indiana chapter of ASHRAE. Shown with Professor Emeritus William T. Miller (second from right), in whose name the books were awarded, are (l to r): George R. Rawlinson, Carl E. Grinstead, and John P. Kamman**

## you'll want to know

*Continues on page 207*

## Here Are Six Job Guideposts For Young Engineers

SELECTING A NEW JOB can be a trying experience, especially for the inexperienced. A. G. Dixon, president of Modine Manufacturing Co. suggests that the following six job guideposts for the young engineer might help to solve the problem. Briefly, they are these:

Take a realistic look at the manufacturing activities of the company you are looking over. Are these of a kind that can intensely interest you, be a challenge to you?

What are the growth prospects of the company?

How personally will you be able to participate in this company's activities? Will you be an individual in whom your supervisors will have a personal interest—both on and off the job—or will you be merely what is termed a "number?"

How do you—your wife also if you're married—like the community where your prospective employment would take you?

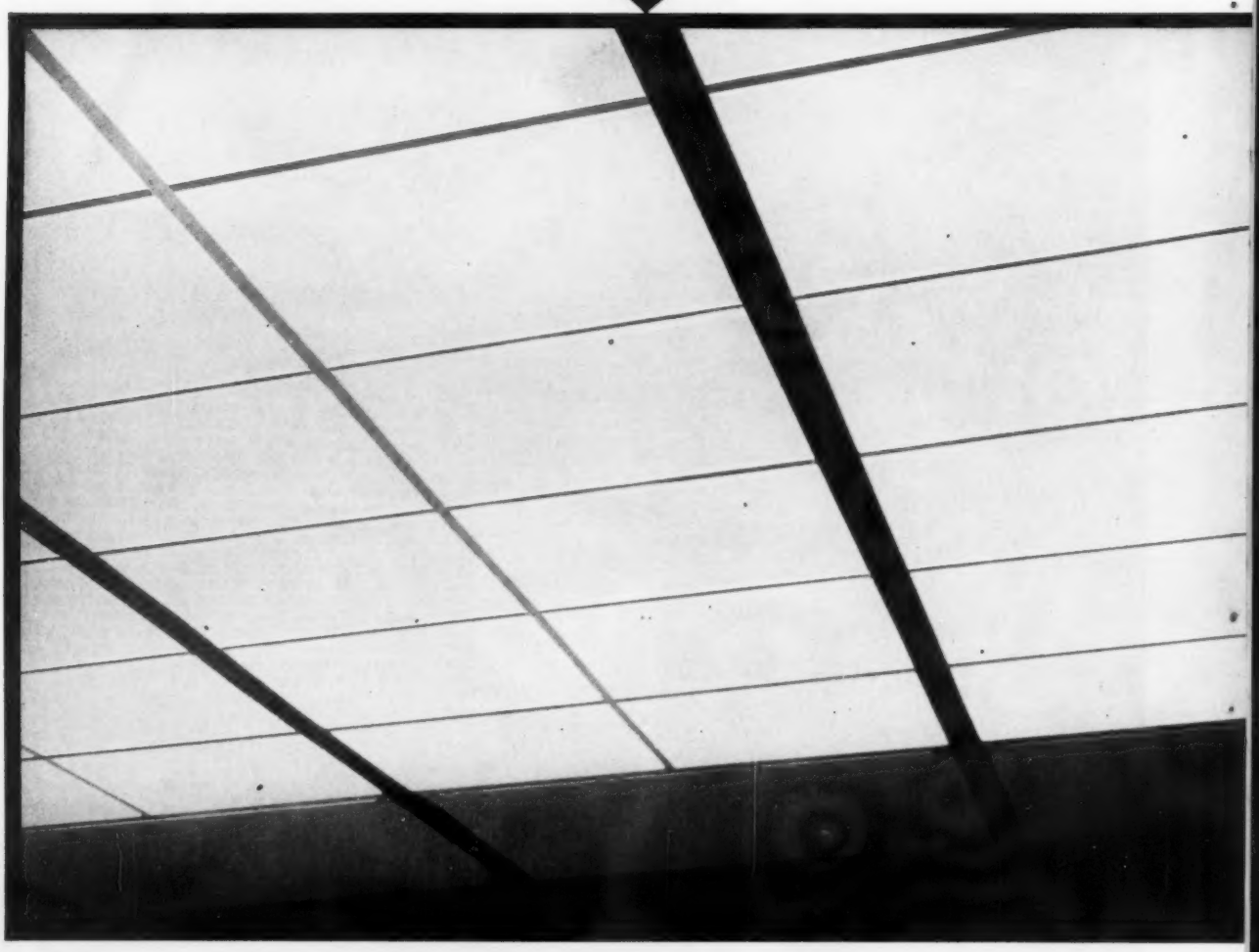
What have you learned about the men with and for whom you will work? Are they of such character and ideals as to prompt you to give them your trust and even admiration?

Of course, look at compensation. However, if the other criteria are satisfied, compensation is likely to shape out well.

## CAN YOU SEE WHERE THE AIR COMES INTO THIS ROOM?

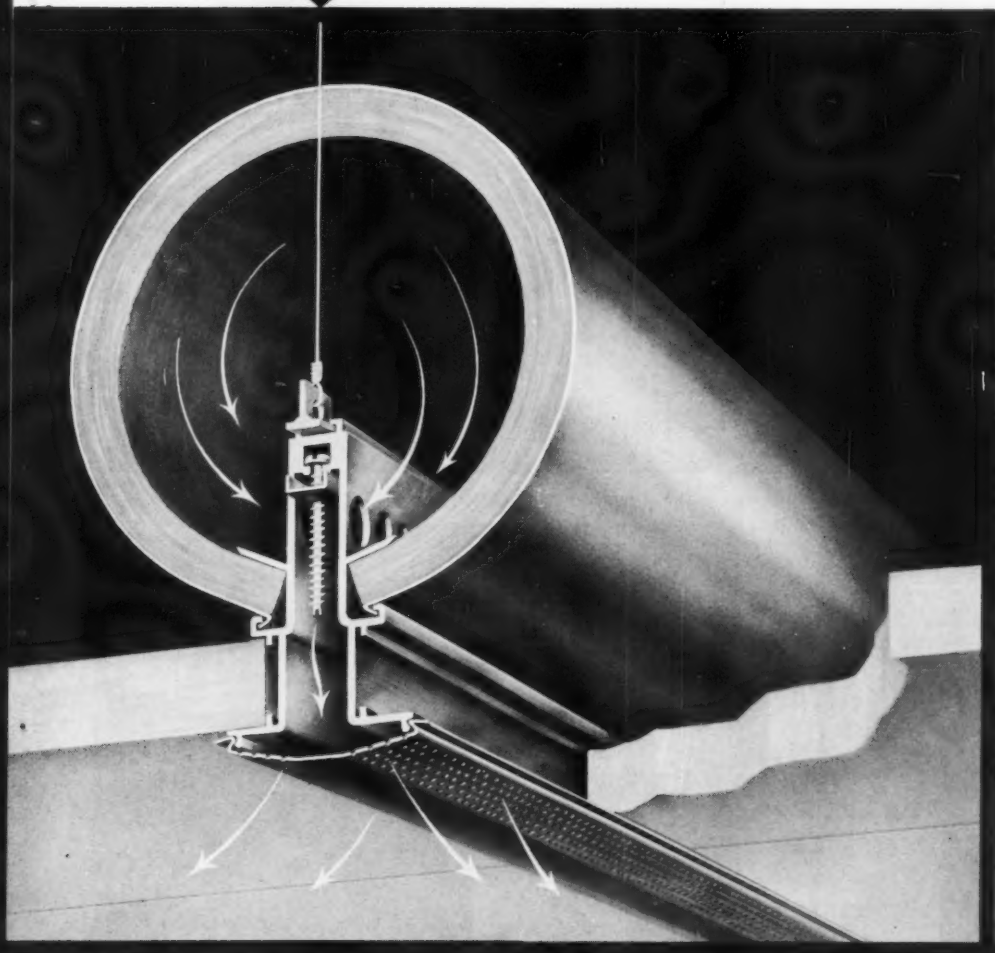
Please turn page...

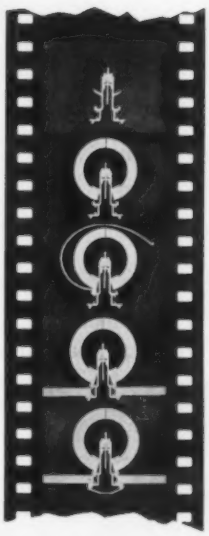
WITH THE FIBERGLAS
ACOUSTI-FLO SYSTEM,
THE AIR IS DISTRIBUTED HERE...



# FIBERGLAS ACOUSTI-FLO SYSTEM COMBINES THE MOST WANTED FEATURES IN AIR DISTRIBUTION

# EVENLY...SILENTLY... EFFICIENTLY... LIKE THIS





**SOUND SLIDEFILM** shows how Acousti-Flo System is installed step by step. Ask for a personal or group showing.

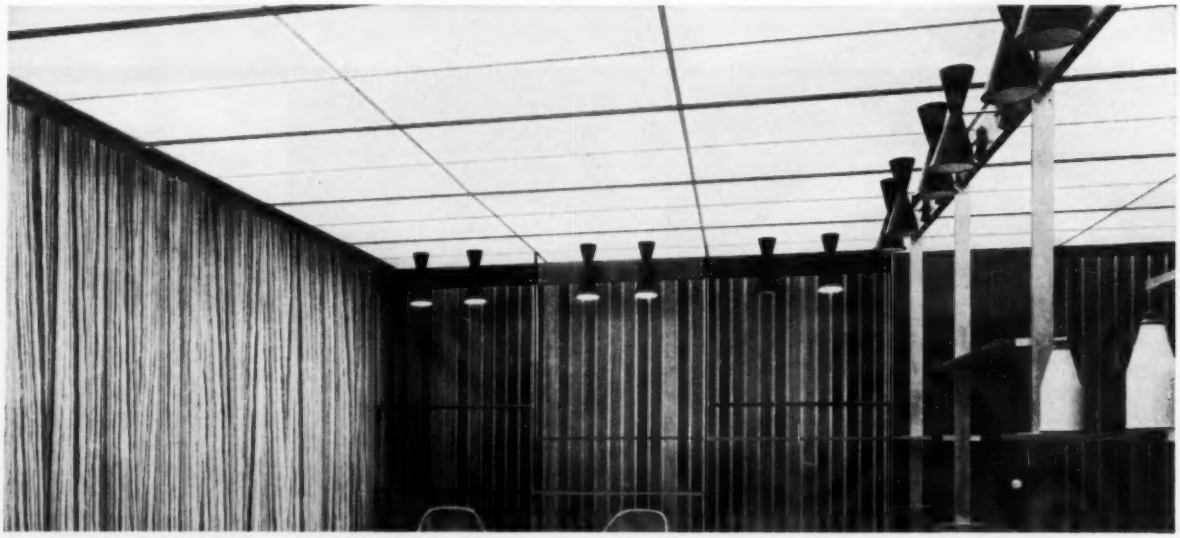
*T-M. (Reg. U. S. Pat. Off.) O-C. F. Corp.

- **RAPID, DRAFT-FREE, UNIFORM AIR DIFFUSION.** In this system, the air flows through a Fiberglas* tube, and out through perforations all along the ceiling suspension bar and decorative snap-on cap (see cutaway view above). Distribution is uniform, positive, and controlled from end to end. There are no surprises after installation. No drafts, no "dead spots," no noise.
- **SIMPLE INSTALLATION, ADJUSTMENT AND MAINTENANCE.** The four parts of the Acousti-Flo* unit quickly assemble to become the air distribution system and ceiling suspension device. Outlet dampers can be adjusted with a screwdriver. Dirtying of the ceiling around the diffuser is almost non-existent.
- **FREEDOM OF CEILING SELECTION AND LIGHTING.** Any number of ceilings may be specified. But Fiberglas Acoustical Tile, Ceiling Board, and Polarizing Light Panels are perfect companions to this system.
- **RELOCATION OF PARTITIONS WITHOUT COSTLY ALTERATION OF DIFFUSER OUTLETS.**

**For further information...**

# PERFORMANCE-PROVED...ACOUSTI-FLO AIR DISTRIBUTION SYSTEM

The Fiberglas Acousti-Flo System is simplicity itself. With only four parts to assemble, it's practically foolproof to install . . . easy to adjust. Conditioned air from the Acousti-Flo Bar Cap mixes gently and rapidly with room air. Temperature variation from ceiling to floor is at a minimum. Maximum occupancy comfort is assured at all times.



**WITH THE ACOUSTI-FLO SYSTEM,** the air distribution becomes part of the decorative scheme; unnoticeable but efficient.

**PARTITIONS CAN BE MOVED AT WILL** without the need for disturbing or relocating the diffuser outlets.

**THE ACOUSTI-FLO SUSPENSION BAR** is flanged to support all types of ceiling—tile, board or luminous panels.

Specify the Fiberglas Acousti-Flo System for your next ceiling project. For further information, or a showing of the new Acousti-Flo slidefilm, see your Fiberglas representative, or write: Owens-Corning Fiberglas Corporation, Industrial & Commercial Division, 717 Fifth Avenue, New York 22, N. Y.

OWENS-CORNING RESEARCH pioneers new ideas in OWENS-CORNING FIBERGLAS

FLINTKOTE® **VAN-PACKER**® Refractory Industrial Stacks

Solving Industrial Stack Problems

# Van-Packer offers a wide choice of stacks to meet virtually every need

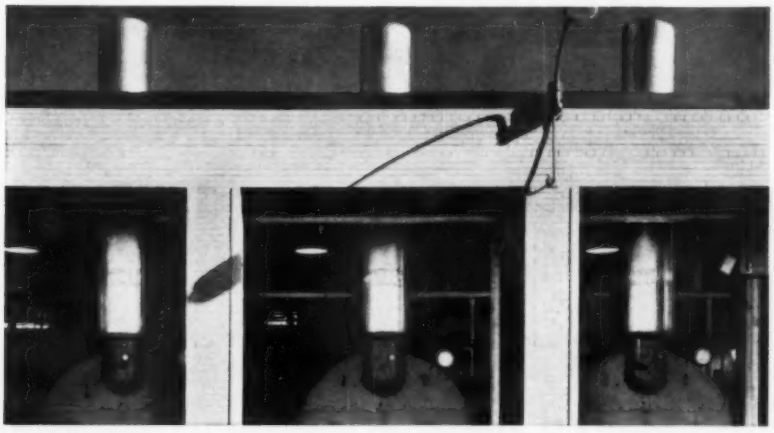
Because Van-Packer refractory stacks are factory-built in modular sections with two types offered, they provide great flexibility to meet varied application requirements.

You can specify any of eight inner diameters: 10, 12, 15, 18, 21, 24, 30, or 36 inches. The 3-foot sections assemble to heights up to 180 feet. They install inside or outside the building, and can be superimposed on the equipment served, floor supported, installed on concrete or brick pier foundations, or supported by wall brackets. Breechings are made with Van-Packer straight sections.

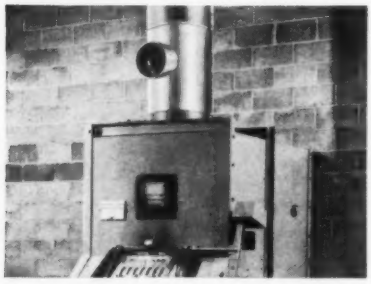
Underwriters' Laboratories, Inc. ® INSPECTED Van-Packer Model HT Smokestack

*Van-Packer Model HT Industrial Stack* is the only stack listed under the Factory Inspection and Label Service Program of Underwriters' Laboratories, Inc. for commercial and industrial incinerators, boilers and furnaces.

Van-Packer Model BF stack (not UL-listed) is a low cost refractory stack for boilers and furnaces with flue gas temperatures up to 800°F.



*Three Van-Packer 30-inch I.D. Model BF Industrial Stacks on these boilers provide highly efficient, low-cost installation at this Chicago-area high school. Refractory construction of these stacks provides high draft for efficient operation of the equipment. Stack cost is about the same as steel stacks for the same application, yet the non-corroding refractory of the Van-Packer provides an average stack life three times greater than steel stacks. An aluminized steel jacket which encases each 3-foot stack section requires no painting.*



*A Van-Packer Model HT Industrial Stack serves incinerators with flue gas temperatures to 1800°F — or 2000°F for brief periods of forced firing.*

For complete information on Van-Packer Industrial Stacks, please write for Bulletin IS-49. Your copy will be sent promptly.

## Stack installs inside or outside

Van-Packer stacks are easily installed on outside walls of buildings to serve the equipment.

An insulated thimble, flashing and counter flashing offered with Van-Packer stacks lets you safely design for inside installation with minimum clearance, even through combustible floors and roof.

## For residential use specify Van-Packer all-fuel chimney

Here's a low-cost, factory-built tile-lined residential chimney that's safe and attractive. Specify either metal or asbestos-cement housing with embossed brick design. Choice of four nonfade brick colors: red, white, buff, and gray. Factory-built 2-foot flue sections have ⅝-inch fire clay tile liner, 3-inch vermiculite-concrete insulating wall, and asbestos-cement outer jacket. Van-Packer chimney is UL-listed for all fuels, is safe for incinerators. Write for Bulletin RS-1.

FLINTKOTE® VAN-PACKER®

**The Flintkote Company**

*Manufacturers of Diversified Products for Home and Industry*

30 Rockefeller Plaza, New York 20, N. Y. Phone: PLaza 7-5500

**In the West:** Pioneer Division, The Flintkote Company, P. O. Box 2218, Terminal Annex, Los Angeles, Calif.

**In Toronto, Ontario:** The Flintkote Company of Canada, Ltd.

# WHY DO MORE AND MORE SPECIFICATIONS CALL FOR Phillips COOLING TOWERS?

# BECAUSE THEY ARE THE ONLY COOLING TOWERS CUSTOM ENGINEERED!

**for the correct solution to your problem... specify**

**Phillips CUSTOM ENGINEERED COOLING TOWERS**

It stands to reason—every water tower installation has different problems. It may be noise... freezing... space... maintenance... atmospheric conditions... or any other. There is no stock answer to varying job conditions.

That's why every day, more and more specifications call for PHILLIPS CUSTOM ENGINEERED COOLING TOWERS. Here are towers designed to give you the most efficient... most economical solution possible for your particular problem.

Put PHILLIPS... the cooling tower specialists with unrivaled experience to work on your next job. You'll like the results.

## EVERY STEP CUSTOM ENGINEERED

**CASINGS**
Selection of material to fit Architectural treatment and surrounding conditions.

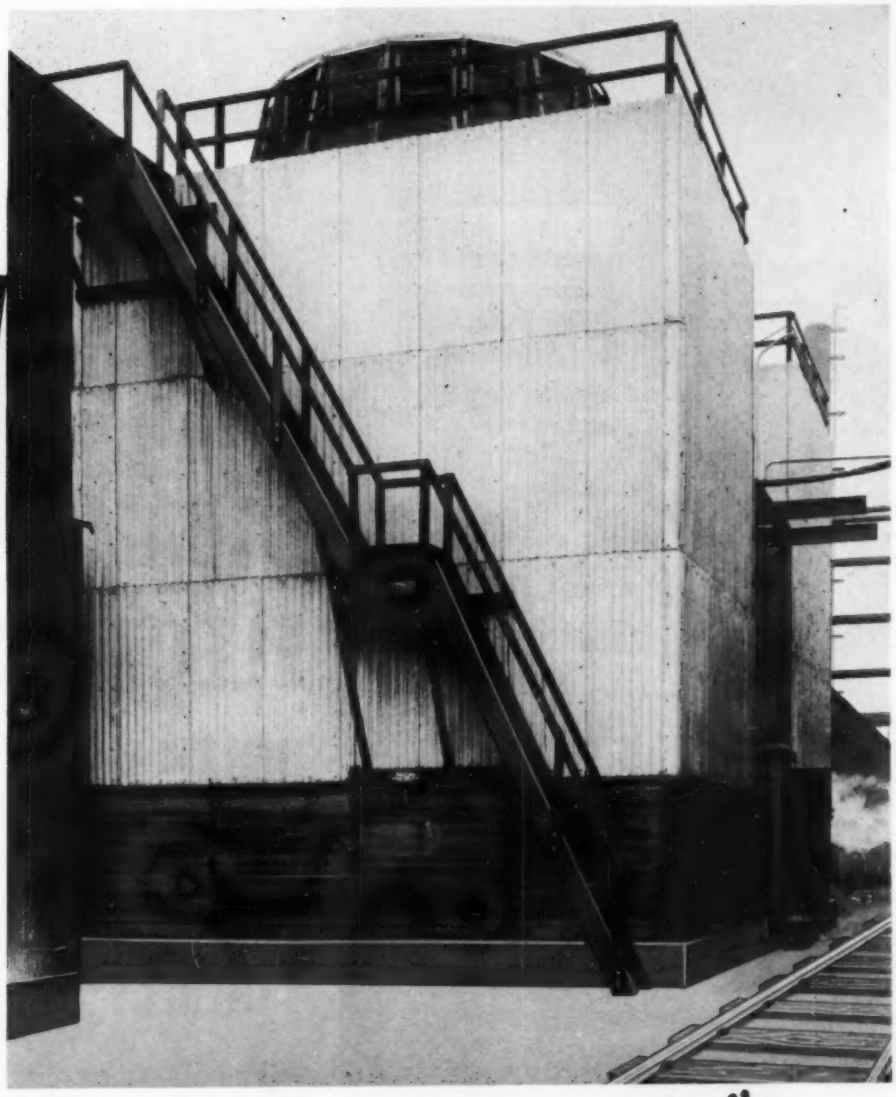
**BASINS**
Redwood, stainless steel, galvanized steel, carbon steel up to and including ¼" thickness with any desired coating, reinforced concrete basins supported on steel beams.

**DISTRIBUTION SYSTEM**
Spray nozzle type or open Weir gravitational type system.

**FANS**
Multi-blade, adjustable propeller type fan in cast aluminum, stainless steel or Monel. Either direct driven fan in small sizes or indirect right angle worm gear drives.

**FILL**
Redwood or pressure treated Douglas Fir. Slip-fit, self-supporting for easy removal for interior maintenance.

**FRAMEWORK**
Hot dipped galvanized structural steel .250" minimum thickness. Redwood or pressure treated Douglas Fir.



Midvale-Heppenstall Co.
Nicetown, Philadelphia, Pa.

*Consulting Engineer:*
Swindell-Dressler Corp.
Pittsburgh, Pa.

## another problem solved by: Phillips CUSTOM ENGINEERED COOLING TOWERS

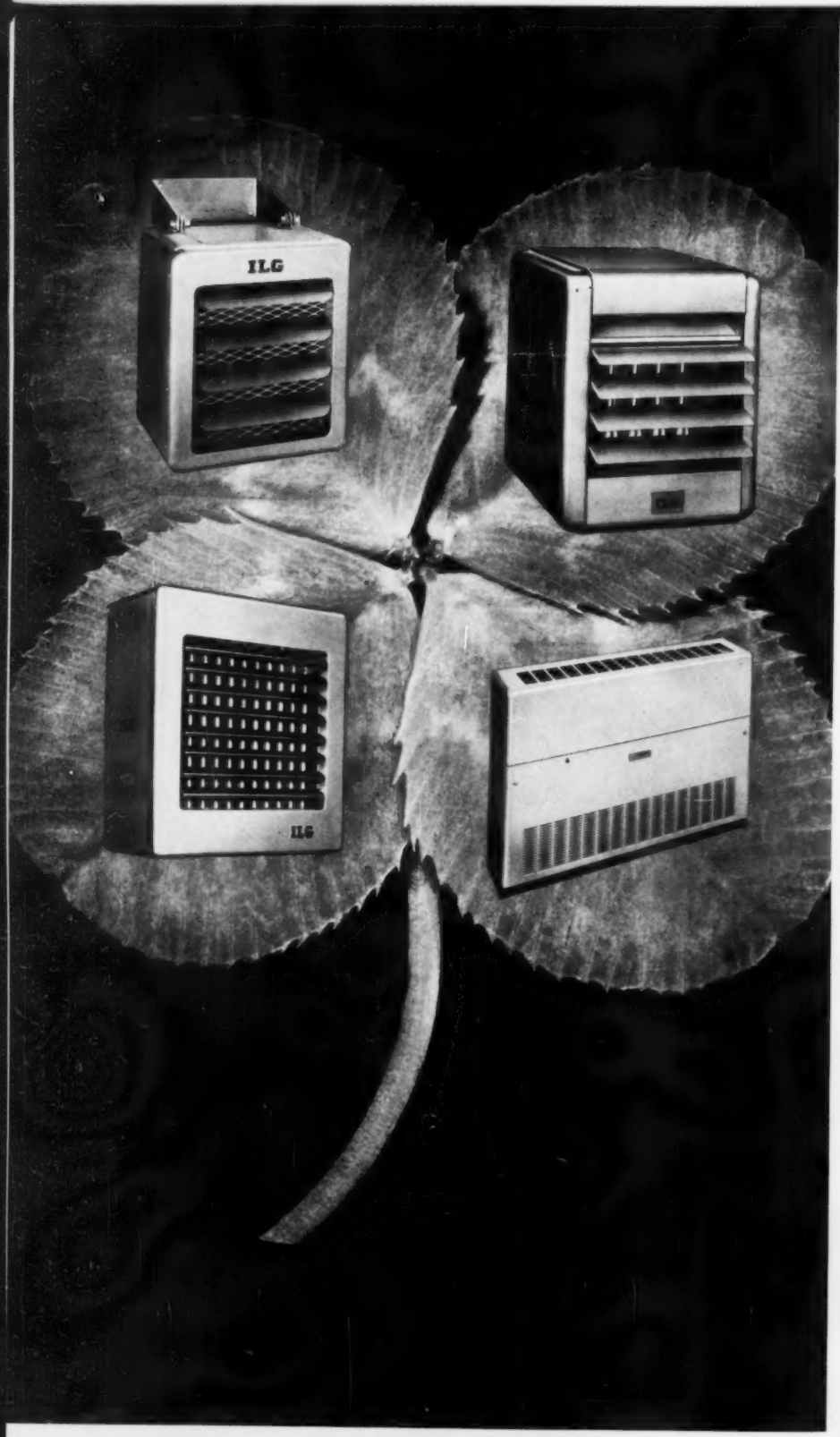
**the problem –** To fit a cooling tower of 4,000 gallons capacity in a small space between an odd-shaped mill building on one side and a railroad siding on the other.

**the solution –** A PHILLIPS CUSTOM-ENGINEERED COOLING TOWER, using every square foot of available space and conforming to the shape of the building, was designed for this installation.

**SPECIAL FEATURES ON ALL TOWERS**

Corrosion Resistant Hardware. Aluminum or Stainless Steel Fans. Nailless Redwood Filling Removable at Tower Base. Nailless Three-Pass Redwood Eliminators. Removable Louvers.

WRITE FOR LITERATURE




# WHEN IT'S GAS, STEAM, ELECTRIC UNIT HEATERS . . . YOU'RE IN CLOVER WITH

*BE RIGHT . . . WRITE IN*

ILG®

**Simple to Install on Ceiling or Wall.** Steel hanging brackets make Ilg All-Electric Unit Heaters simple to install *anywhere.* Non-glowing, steel-sheathed black heat type replaceable heating elements . . . plus built-in thermal cutout . . . give positive protection against overheating. Patented Type "Q" aluminum fan wheel direct connected to single or 3-phase motor assures silent operation. Eleven sizes from 1½ kw., 5118 BTU/hr. to 36 kw., 122,832 BTU/hr. WRITE FOR CATALOG 809.

**Two Types of Ilg Gas Fired Heaters.** *Propeller type* (shown here) is the smallest and lightest unit on the market. Fully automatic controls. Corrosion-resistant aluminum steel heat exchanger. Direct-connected, permanent-split capacitor motor. Ten sizes from 25,000 to 250,000 BTU/hr. input. *Centrifugal type:* for moving large volumes of air at low tip speed. Eight sizes from 50,000 to 250,000 BTU/hr. input. Automatic controls. Aluminum steel heat exchanger. WRITE FOR CATALOGS 286 and 1501.

**Choice of Steam or Hot Water Heaters.** Ilg *Horizontal Heaters* come in 19 capacities with low-speed, 4-blade aluminum fan wheel. Copper tube and aluminum fin heating coils brazed to 1-piece headers. 4-way pipe connections for simple hookups. Totally enclosed shaded-pole or split-phase motor. *Vertical Heaters* in 19 capacities. Type V for standard outlet temperatures; Type VL for low outlet temperatures. Heating coils similar to horizontal units. WRITE FOR CATALOG 1202.

**Cabinet Heaters.** Seven basic sizes; 21 hot water ratings; 14 steam ratings. Choice of blow-through type with direct-drive fan assembly or draw-through type with mounting; non-recessed, semi-recessed, fully recessed or concealed. *Electric Cabinet Heaters* have 2- and 3-speed motors, blow-through and draw-through. Capacities 3.33 to 30.0 kw. WRITE FOR CATALOGS 1301 and 1801.

# ILG ELECTRIC VENTILATING CO.

2826 No. Pulaski Road, Chicago 41, Ill.
Offices in 60 Principal Cities
Member of Air Moving and Conditioning Association, Inc. (AMCA)

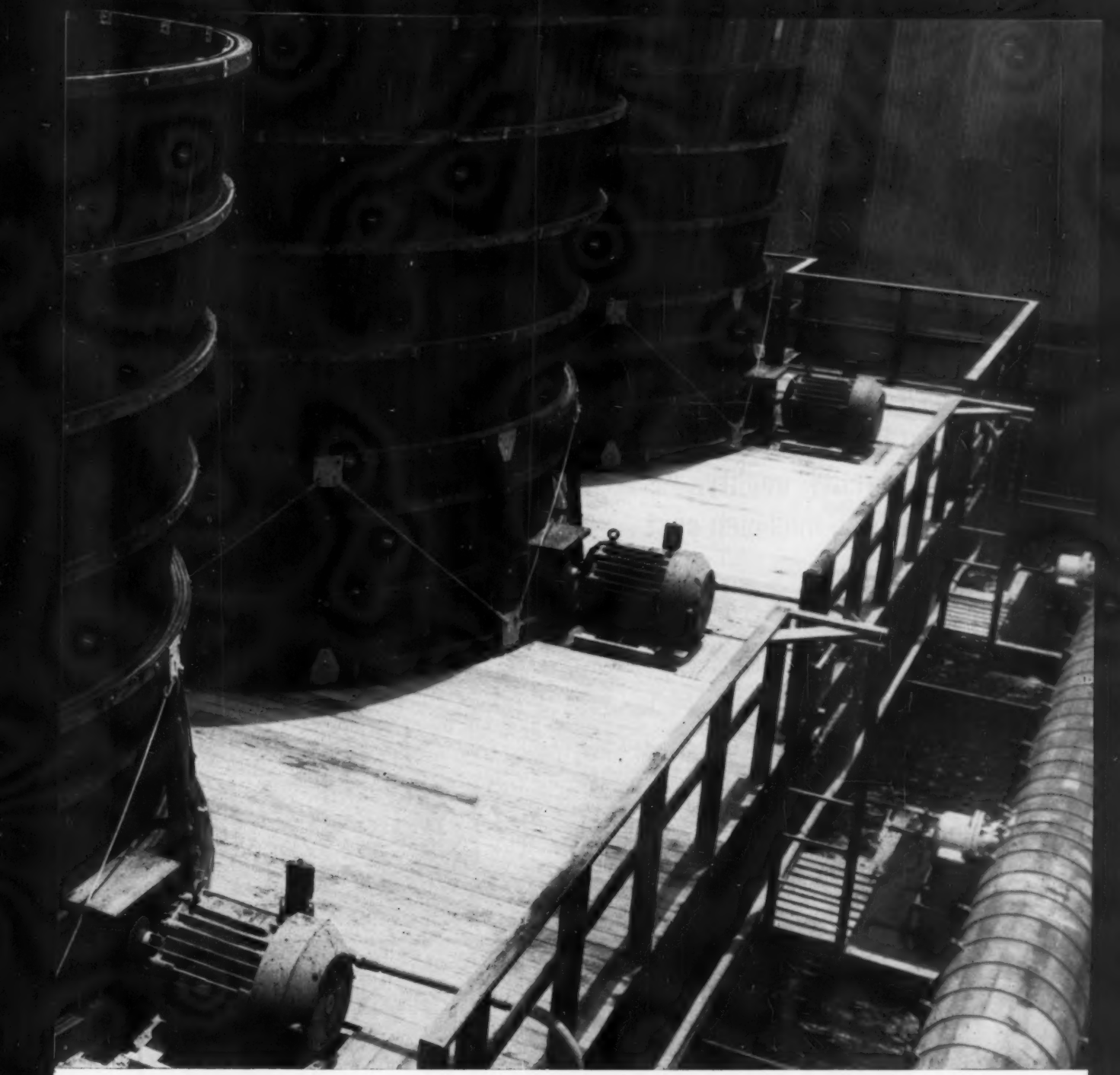
# CENTURY MOTORS PULL HEAT

Forty-two stories above Dallas, on top of the South's tallest building, three Century 50 horsepower totally-enclosed fan-cooled motors are driving induced draft fans to keep the Southland Center cool.

A Century motor drives a 20-foot fan on each of three cells of this cooling tower. During the hot summer months, especially, the air conditioning of the immense Southland Center is dependent upon the continuous operation of these fans—and, upon the dependable, continuous operation of Century motors.

Heat absorbed by air-conditioning and refrigerating equipment must be removed efficiently. Maintaining efficient condensing temperature in a system of this large capacity, requires 20,000 gpm of cold water. And conservation of this gallonage with uniform performance at all times is necessary—the cooling tower is an important factor in the overall system.

Dependable Century motors are a vital part of installations such as this one where the continuous operation of the fans is so important. The three Century 50 horsepower, two-speed, totally-enclosed fan-cooled motors used in this installation are subject to all sorts of



# OUT OF A 42-STORY BUILDING

unfavorable weather conditions—heat, moisture, rain, wind, corrosion. But they keep working . . . continuously. They keep working because these motors are made of strong, tough cast iron and will withstand the elements in unguarded outdoor locations.

These totally-enclosed fan-cooled motors are constructed so that no outside air (with dust, dirt, moisture, etc. in it) is circulated into the motors. Internal fans circulate *clean* air within the enclosed frames. An external fan blows air over the ribbed frames for maximum transfer of heat to the outside air. These Century motors can take it, because they are designed and built to handle such jobs.

Century application engineers throughout the country understand industry's motor requirements. Call the Century Office nearest you, or your Authorized Century Distributor for more information about Century's complete line of motors—from 1/20 to 400 horsepower.

**CENTURY ELECTRIC COMPANY**

**St. Louis 3, Missouri** *Offices and Stock Points in Principal Cities*

Century

59-24

## Compare! In centralized control panels, Honeywell

# YOU GET A CUSTOM JOB

### Three new standardized panel lines manufactured entirely by Honeywell assure uniformity, quality, fast delivery, minimum cost

Now you can have a centralized control panel built to your exact specifications, and not wait months for delivery. Honeywell's new standardized units can be combined any way you like to give you a truly *custom* job. And because sizes and construction techniques have been standardized, you get the same high quality and uniformity every time, with fast delivery and at a minimum cost. You'll also find them much easier to specify!

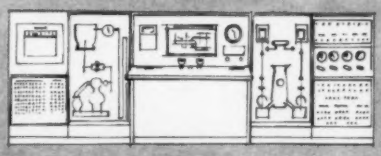
Most important, all Honeywell panels are manufactured entirely by Honeywell in a complete, experienced panel factory. Nothing is jobbed out—no delays because of dependence on outside sources. You're assured of famous Honeywell quality control every step of the way—design, engineering, steel work, painting, engraving, assembly, wiring and, of course, all controls. *Only* Honeywell backs its control panels with such all-the-way production and service! For details, call your nearby Honeywell office. Or write Honeywell, Dept. AC-7-140, Minneapolis 8, Minnesota.

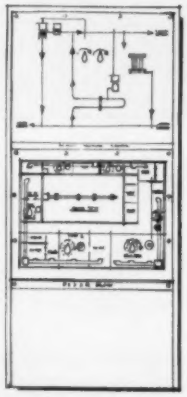
**1**

**Honeywell Selectographic DataCenter***

A whole new concept in system-by-system operation. Builds together block by block. The console enables one man to supervise an entire air conditioning system in a building or group of buildings from a single set of compact controls. Built around the console, in 2′x4′ or 2′x2′ modules, can be permanent system diagrams with pilot lights, alarm signals, instruments and switches; system analyzers; alarms; and controls for other phases of the buildings' mechanical operation. The console itself is 48″ wide x 52″ high.

**Fit units together in any combination!**

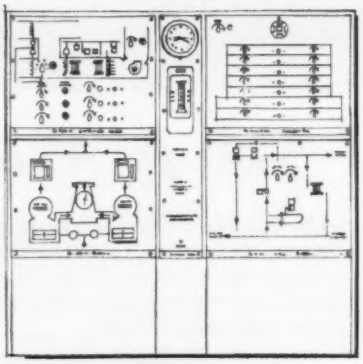




**Specify whatever controls you need!**

**2** **Honeywell Supervisory DataCenter***

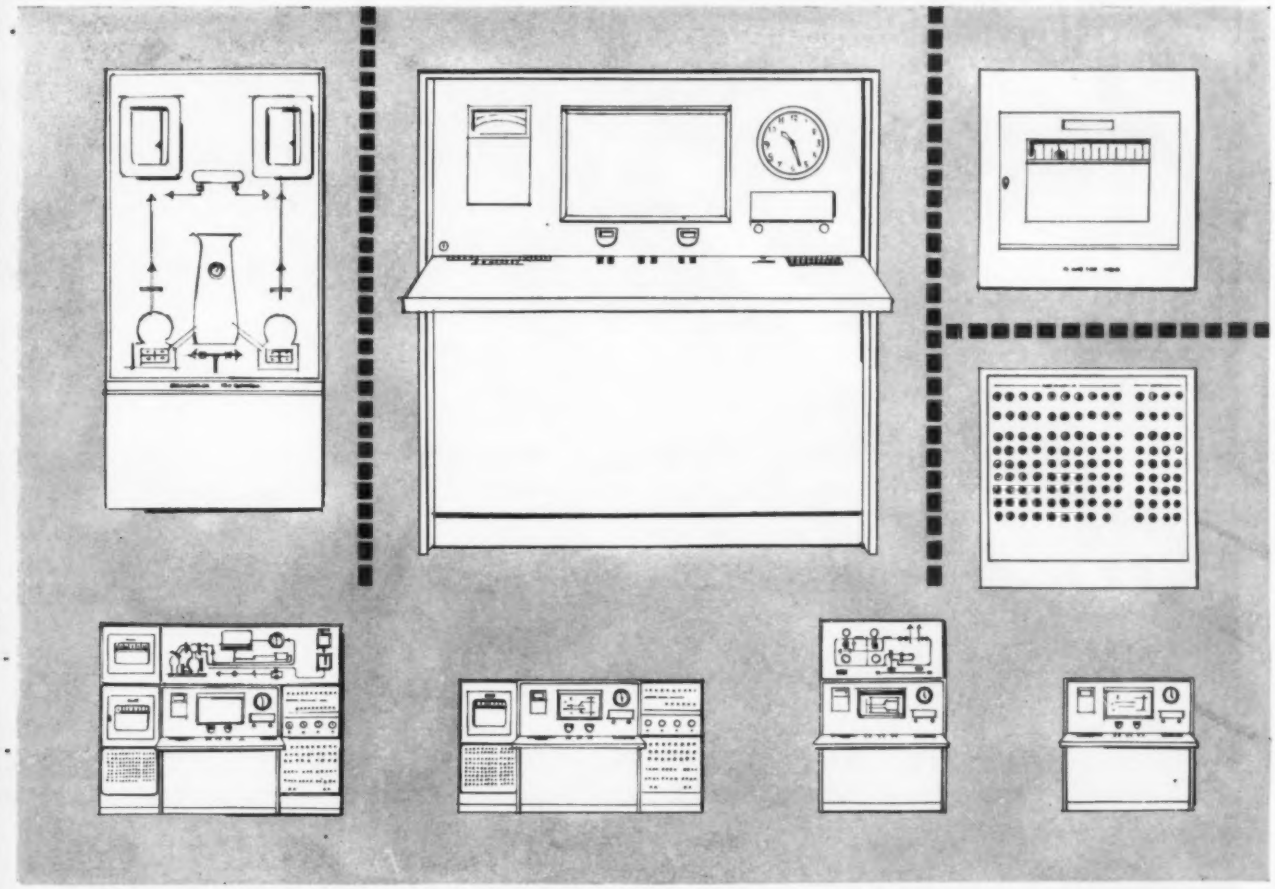
Standardized panels, with system diagrams permanently engraved and color-coded under durable Plexiglas. Highly suited to buildings with relatively few fan systems, or where numerous systems with identical layouts permit use of one diagram for all, with an accompanying panel of pushbuttons and adjustment knobs. Offers the same optional features as the Selectographic. Outside dimensions of the module at left are 36″ wide x 84″ high.



**Modular design gives building block flexibility!**

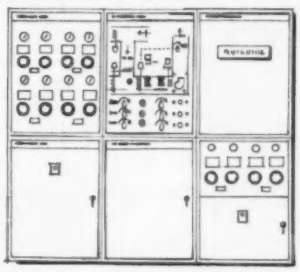
## engineering makes the difference

# FROM STANDARD UNITS!

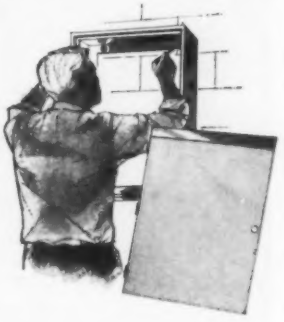


### 3 Honeywell Fan Room Panels

Pre-planned for step-by-step installation. When time comes for roughing-in, Honeywell ships just the ring frame. Knockouts in the rings permit easy wiring connections between the units, using factory-wired plugs. When needed on the job, the controls are shipped factory-mounted on a subpanel that forms the back of the cabinet and, when suitable, on the door. Panels are light, immediately available, easy-to-mount, and safe from damage. Ring frame is 24″ wide x 32″ high.



**New two-part shipment!**



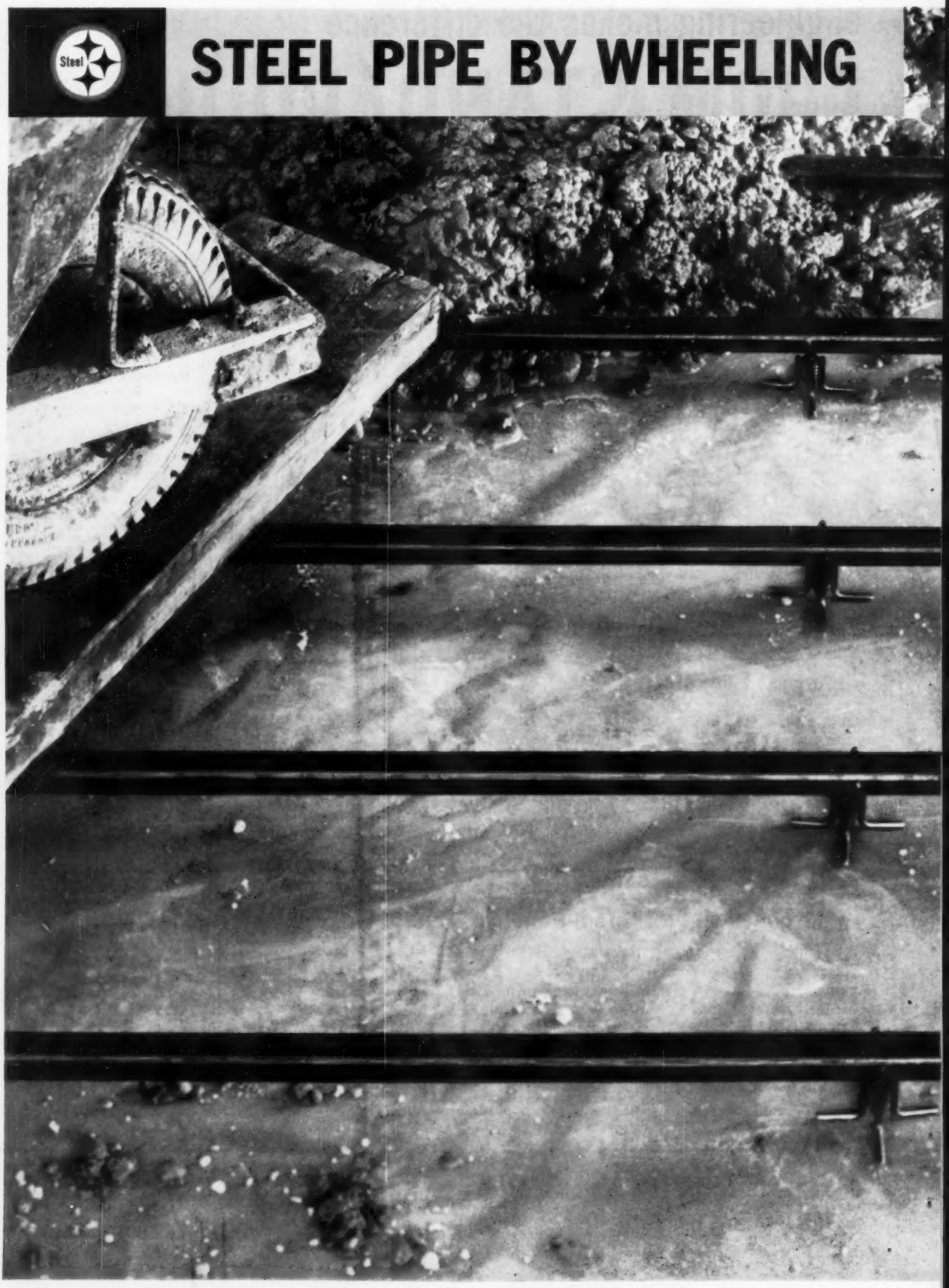
**Honeywell**

*Trademark

First in Control

SINCE 1885

HONEYWELL INTERNATIONAL Sales and service offices in all principal cities of the world. Manufacturing in the United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.


Steel
STEEL PIPE BY WHEELING

# So easy to use... so hard to abuse!

Bend it . . . bang it . . . bury it under tons of concrete! Rugged Wheeling CW Steel Pipe takes such torture in stride. Then keeps on taking it long after most other pipe has failed!

Long experience under a wide range of conditions has proved that Wheeling Pipe has the strength and dependability needed for economical service and continued safe use for years to come.

Wheeling Pipe can withstand amazing abuse. That's because it makes full use of steel's inherent strength and dimensional stability . . . and it's always produced under exacting *American* quality standards.

It's easy to use and handle, too. Made of uniform steel – Wheeling Pipe has even wall thicknesses and accurate circumferences. So this rugged pipe cuts easily . . . bends smoothly . . . welds surely.

Ask your Wheeling man about Wheeling CW Steel Pipe, both black and galvanized. Or write to Wheeling Steel Corporation, Wheeling, West Virginia.

WHEELING STEEL

**WHY WHEELING STEEL PIPE IS FIRST CHOICE!**

- *Lowest cost with durability*
- *Strength unexcelled for safety*
- *Formable – bends readily*
- *Weldable – easily, strongly*
- *Threads smoothly, cleanly*
- *Sound joints, welded or coupled*
- *Grades, finishes for all purposes*
- *Available everywhere from stock*

***ALWAYS INSIST ON PIPE MADE IN THE USA!***

**WHEELING STEEL CORPORATION · IT'S WHEELING STEEL!**

*District Sales Offices at Atlanta, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Detroit, Houston, New York, Philadelphia, St. Louis, San Francisco, Wheeling*

*Proven dependability for America's large commercial buildings*

# TACO HOT WATER HEATING

A rapidly increasing number of consulting engineers are discovering *more* reasons for specifying Taco products. They know that Taco's more than 40 years of experience in the heating and air-conditioning fields insures exacting standards of quality control, complete reliability of performance.

Nine Taco pumps are the heart of the hydronic heating system in Milwaukee's new American Bowling Congress Building. Only Taco "LP" pumps, used in this installation, enabled engineers to specify precisely the pump needed for a particular system — to "tailor" the pump to the job.

With total range efficiency engineered into every Taco pump, the consulting engineer is assured that he has specified the most economical unit obtainable. He has the added assurance that the pump will give years of trouble-free operation; at the lowest possible noise levels.

In Philadelphia, the recently completed Penn Center Cooperative Apartment Building installed nine Taco pumps for heating and four Taco heat exchangers for service water heating. In this installation, as well as in the ABC building, the efficiency engineered features of Taco equipment provide the total comfort required in

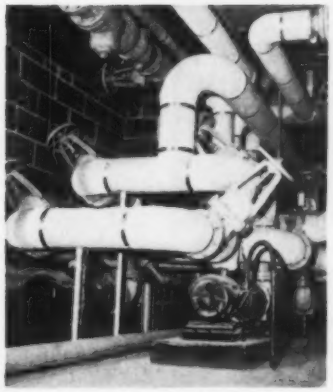
# EQUIPMENT

today's modern buildings. Features such as self venting centerline discharge make installation and servicing economical and easy. Special alloy shaft sleeves and advance design mechanical seals assure long, dependable operation.

Regardless of what *your* needs may be in hydronic heating and cooling systems — whether you require standard or custom-built equipment — Taco can meet all of your specifications with significant cost-saving advantages.

See your local wholesaler, or write TACO HEATERS, INCORPORATED, 1160 Cranston Street, Cranston, Rhode Island.

Milwaukee's American Bowling Congress Building uses TACO "LP" Pumps exclusively for economical hydronic heating. Arthur Seidenschwartz, Jr., Engineer; Paul J. Gronav Co., Contractor.



Penn Center Cooperative Apartments in Philadelphia. This completely tenant-owned apartment building relies on TACO hydronic equipment for efficient heating and domestic hot water. George Idell, Architect; W. G. Flurer, Engineer; Mayson's, Inc., Contractor.

Taco

*EFFICIENCY ENGINEERED PRODUCTS*

# CLEAN AIR by AAF

## *In Chicago's McCormick Place....*

Architects: Shaw, Metz & Associates, Chicago; Consulting Architects: Edward D. Stone, New York and John W. Root, Chicago; Mechanical & Electrical Engineers: John Dolio & Associates, Chicago.

## AAF ROLLOTRONS keep air clean in mammoth exposition building

The air-cleaning requirements are extremely important for a 10-acre building that includes 320,000 sq. ft. of exhibition space, a restaurant, a cafeteria and 23 meeting rooms. Because of the varying operations and the fact that as many as 30,000 people might be in the building at one time, the filters had to be *efficient*. Because of the sheer size of the installation, they had to be *automatic* and *maintenance-free*.

The building-planners turned to AAF because only AAF makes *all kinds* of filters. Only by considering all kinds can you make sure of getting optimum correlation of filter performance, filter cost and filter maintenance.

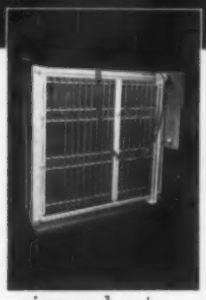
From the complete AAF line, the automatic ROLLOTRON was selected to do the mammoth job at McCormick Place. It offered the efficiency of an electrostatic precipitator and the minimum maintenance of an automatic-renewable, disposable-media air filter. Minute dust particles are attracted to the dry plates of the agglomerator section. As they build up (agglomerate) they are swept off the plates and onto the bonded glass fiber media of the storage section. This glass fiber blanket moves intermittently down the face of the storage section and winds up the accumulated dirt load into a compact roll at the bottom.

There's no oiling, no washing, no water, no freezing, no drains. Maintenance involves replacing the used media roll with a new one—required about once a year in normal service—and occasionally wiping down the ionizer wires and struts.

Different needs require different filters. That's precisely why AAF makes all kinds. And no matter what the need, AAF has the filter. For example: Detroit's Convention Arena . . .

# .....In Detroit's Convention Arena

Architects & Engineers:
Giffels & Rossetti, Detroit.



## AAF Electro-CELL units clean air in striking new civic building

Convention Arena is a refreshing addition to the Detroit skyline. It is circular, of dark green granite accented by white marble pilasters. Conceived as a supporting unit to Cobo Hall, the Arena is self-sustaining and will house political conventions, music festivals, boxing matches, basketball, hockey, ice shows and other events.

Though Convention Arena is unique in design, the building planners turned to a well known, time-tested formula for cleaning interior air. From the complete AAF line they selected the Electro-CELL electrostatic precipitator.

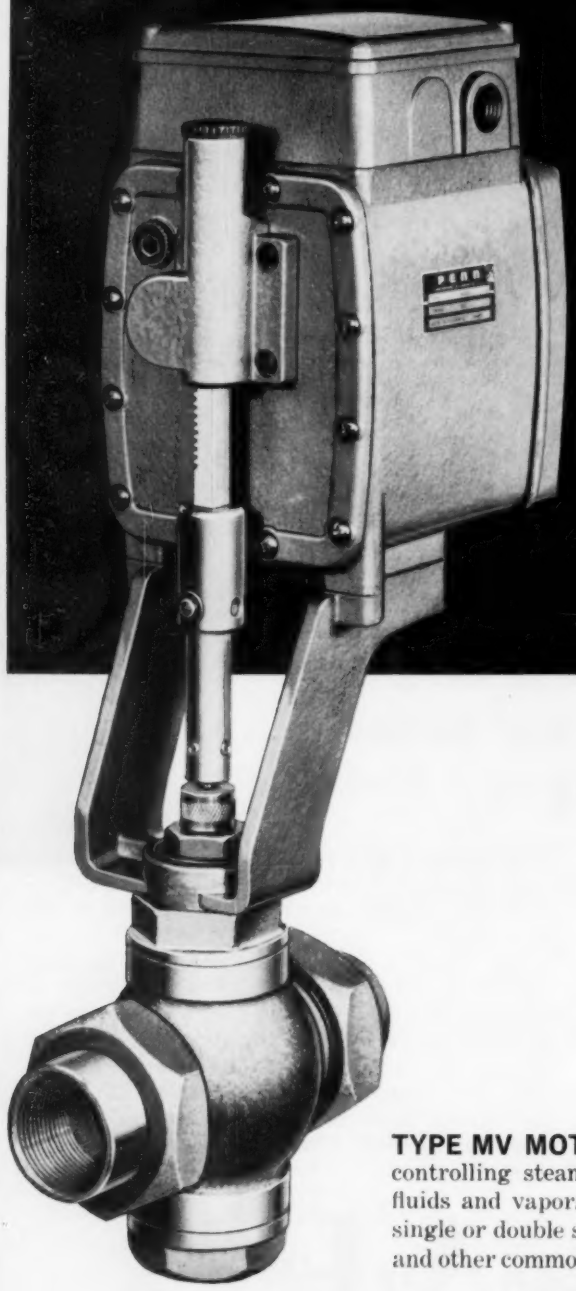
The Electro-CELL provides high-efficiency electrostatic air cleaning and automatically washes and re-oils its plates at the same time.

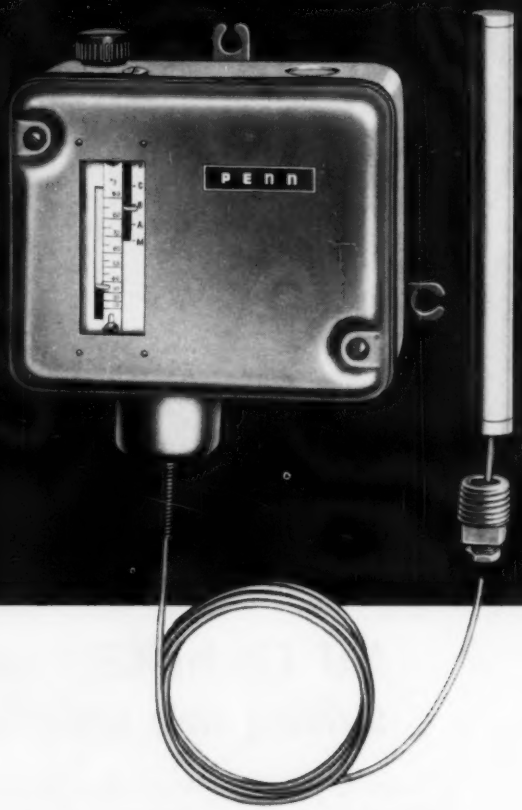
For complete product information on the Electro-CELL call your local AAF representative or write us direct for Bulletin 258. For data on the ROLLOTRON ask for Bulletin 249. Address: Robert Moore, American Air Filter Company, Inc., 373 Central Avenue, Louisville, Kentucky. In Canada, American Air Filter of Canada, Ltd., 400 Stinson Blvd., Montreal 9, Quebec.

AAF **American Air Filter**

BETTER AIR IS OUR BUSINESS

# PROPORTIONAL BY PENN






**TYPE TB TEMPERATURE CONTROL** with adjustable throttling range for accurate control of air and liquid temperatures in heating, air conditioning, industrial process and ventilating applications.

**TYPE MV MOTOR ACTUATED VALVE** for controlling steam, water, air, gas, oil and other fluids and vapors. The line includes two-way . . . single or double seat . . . three-way, pilot balanced, and other commonly used types.

# CONTROLS

...new and modern, dust tight and splash proof...for positioning air dampers, control valves, programming devices, burner fuel valves, and similar equipment in heating, air conditioning, and industrial applications.

**TYPE MA MOTOR ACTUATOR** for use with various types of electrical control devices such as a simple push-button station, a slide wire type temperature or pressure control and more complex electronic controls. Available with various operating speeds and output torques. Other features include plug-in relay, position indicator and models with built-in auxiliary switch.

**TYPE PB PRESSURE CONTROL** with adjustable throttling range assures accurate control of steam and gas pressures in heating, air conditioning, and industrial process applications. Normally used to position motor actuator for controlling air dampers, valves, and similar devices.

*Learn more about these modern proportional controls . . . write to Penn factory.*

## PENN CONTROLS, INC. Goshen, Indiana

EXPORT DIVISION: 27 E. 38th ST., NEW YORK, N.Y.

AUTOMATIC CONTROLS FOR HEATING, REFRIGERATION, AIR CONDITIONING, APPLIANCES, PUMPS, AIR COMPRESSORS, ENGINES

"Our installation has performed with complete satisfaction. We believe that it has provided the greatest comfort and the best possible atmosphere for school children and the faculty."

—Rev. W. P. Sauer

"Our installation has performed with complete satisfaction. We believe that it has provided the greatest comfort and the best possible atmosphere for school children and the faculty."

What else can Burgess-Manning say about their Radiant Ceiling when Pastor Sauer has said it so well!

In brief, "air circulation, comfortable uniform heating, dependable performance, ease of maintenance, and *unanticipated economy* in operation" are what hundreds of other schools* also report on their Burgess-Manning Radiant Heating, Cooling and Acoustic Ceiling installation.

Why not look into the superior advantages and true economies of the Burgess-Manning Radiant Ceiling? *Your school is better . . . your budget no bigger.* Write today for complete descriptive literature . . . Bulletin 138-3G

* list on request

Pastor: W. P. SAUER
809 Sixth

ST. JOHN'S LUTHERAN
Decorah at Sixth
WEST BEND, WISCONSIN

Principal: H. GRUENHAGEN
899 Sixth

February 20, 1961

Mr. Howard Harper
DeGelleke Company, Inc.
Burgess-Manning Division
4040 North 126th Street
Brookfield, Wisconsin

Dear Mr. Harper,

St. John's Lutheran School, West Bend was opened to pupils in September 1959. Thus we now have had an experience of substantially two winters with our Burgess-Manning Ceiling and the integral heating and ventilating facilities.

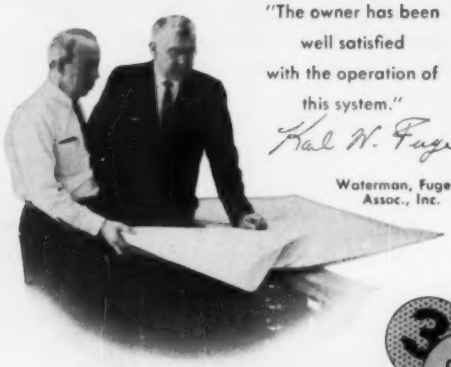
Our installation has performed with complete satisfaction. We believe that it has provided the greatest comfort and the best possible atmosphere for school children and the faculty.

Air circulation, comfortable uniform heating, dependable performance, ease of maintenance and unanticipated economy in operation are all to be included in the specifics of our satisfactory experience. The constant replenishing of fresh air, evenly and almost imperceptibly distributed over the entire room area, helps children remain more alert. There are no objectionable drafts, nor currents of either hot or cold air to combat. We consider ourselves fortunate to have had direction from our architects toward a Burgess-Manning installation.

Yours very truly
St. John's Ev. Lutheran Church

WPS:e

W. P. Sauer, Pastor



"The owner has been well satisfied with the operation of this system."

Karl W. Fuge

Waterman, Fuge & Assoc., Inc.

Karl W. Fuge, Engineer and Arthur E. Waterman, Architect

Burgess-Manning Ceiling Area—7,396 sq. ft.
Architect—Waterman, Fuge & Associates, Inc.
Engineer—Waterman, Fuge & Associates, Inc.
Ceiling Contractor—DeGelleke Co., Inc.

Have your name added to the mailing list for the monthly Burgess-Manning "b.t.u." . . . information-packed on the Burgess-Manning Radiant Ceiling. Write on your letterhead, please.

3 Heating Cooling Acoustic

BURGESS-MANNING COMPANY
*Architectural Products Division*
749 East Park Avenue • Libertyville, Illinois

**MEN**
**WHO SPECIFY**
**VALVES...**

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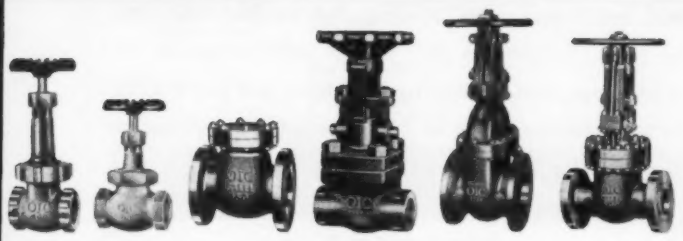
# SEE MORE AND MORE OIC VALVE INSTALLATIONS!

# INSIST ON OIC FOR ALL VALVE APPLICATIONS!



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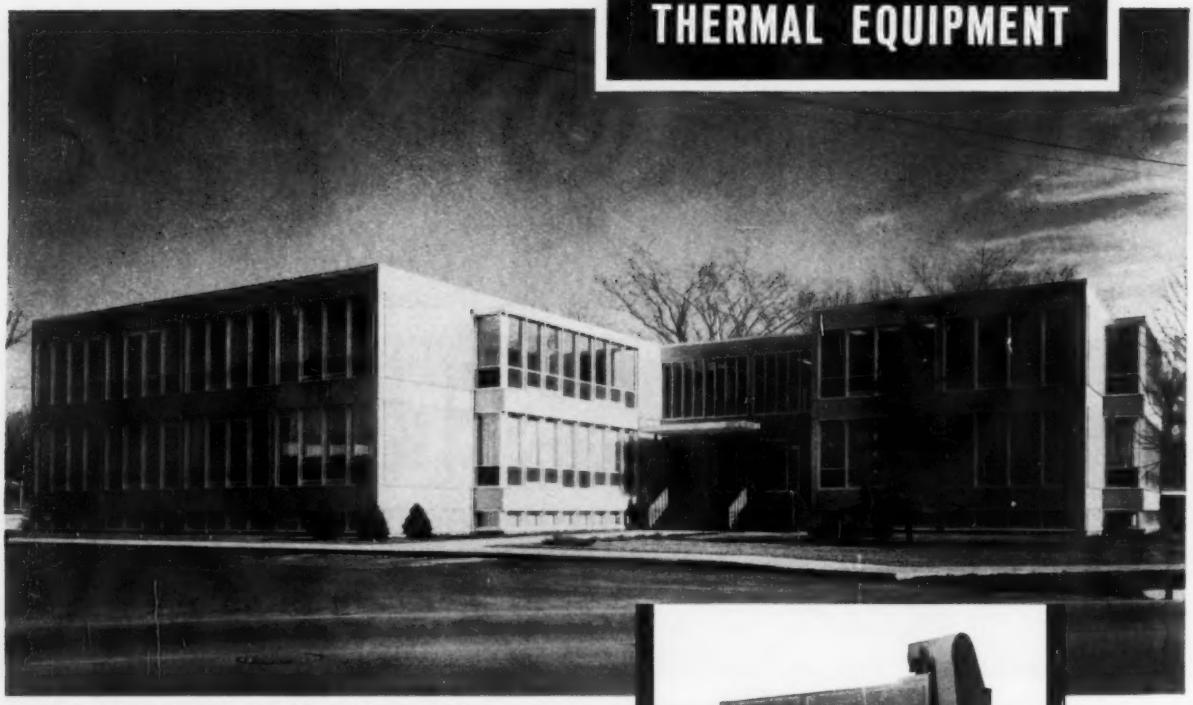

Consulting Engineer: Charles R. McDonald, Arlington Heights, Ill.
Thermal Agent: Barr and O'Dwyer, Chicago, Ill.

Vertical
Central Plant

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GAS FIRED
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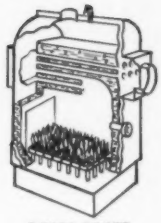
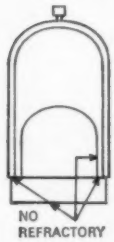
for hot water or steam

Series 34

## Quiet, dependable atmospheric gas combustion with power burner performance



3-PASS BOILER



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**Quiet.** Whisper quiet in operation.

**High capacity.** This IronFirepak generator, with its quiet atmospheric gas burner, gives you the same rated output as the same boiler with power gas or oil firing. You have the additional advantage of an uncomplicated system, free from service complexities and electrical power costs.

**Fuel economy.** Ample furnace volume and controlled mixture of gas and air in compartmented burner permit high combustion efficiency. Heat loss through insulated boiler jacket is negligible. Moderate stack temperature. Minimum electrical requirements.

**No refractory.** Combustion efficiency does not depend upon reflected heat of a hot refractory. Full length water leg firebox. Result—maximum absorption and instantaneous response.

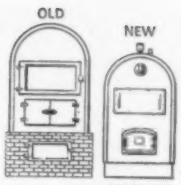
**Low maintenance cost.** Clean burning flame and simple mechanical operation eliminates causes of most service calls. No electric motor, fan or refractory maintenance.

**Compact.** Can be installed in limited space with low headroom.

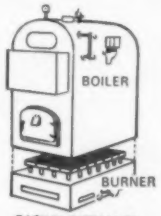
**Easy access.** Large access firedoor for routine inspection.

**Easy installation.** One-piece burner base assembly and one-piece boiler shell easily combined on site. Jacket and controls designed for quick assembly.

**Wide range of sizes and capacities** Outputs from 200,000 Btuh to over 2,000,000 Btuh.




COMPACT

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Please send full information and specifications on IronFirepak Heating Package with atmospheric gas burner.

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# "Here's why I'm switching to H&M central system air conditioners

*. . . I can get just the fin spacing, tonnage and CFM I want."*

Now, Halstead & Mitchell gives you a choice of 6, 7, 8 or 10 fins per inch . . . makes it much easier to match a central fan-coil unit to a particular job or to meet specifications.

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Export Representatives: Sabal-Kielmann, Inc., 15 William St., New York 5, N. Y.

# DEKORON POLY-COR *Instrument Harness specified for new* GENERAL TELEPHONE COMPANY *building*

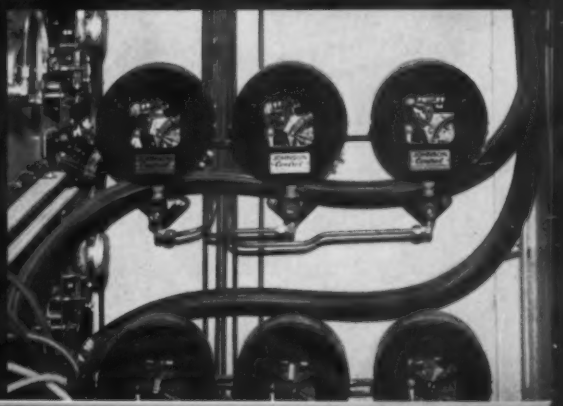
*Architect Engineer:* Steven Berkey Co. • *Air Conditioning Contractor:* F. B. Gardner Co.
*Air Conditioning Controls Contractor:* Johnson Service Co.

Typical of the swing to new Dekoron Poly-Cor all-plastic instrument harness for air conditioning control lines is the new General Telephone Company building at Pomona, Calif.

Poly-Cor is the most advanced instrument line harness made . . . now offers features never before available. New all-black polyethylene for higher temperature operation . . . number coded tubes for faster, easier installation . . . Mylar® vapor barrier. All these features are now standard in new Poly-Cor at no increase in price.

For faster, neater tubing bundle installations, check your local Dekoron products representative. Dekoron products are application-engineered by the company with the greatest application experience.

Rear view of central control panel, located over 600 feet from air conditioning equipment, shows neat installation of Poly-Cor which can be strung like electric wiring without complicated tube bending problems.



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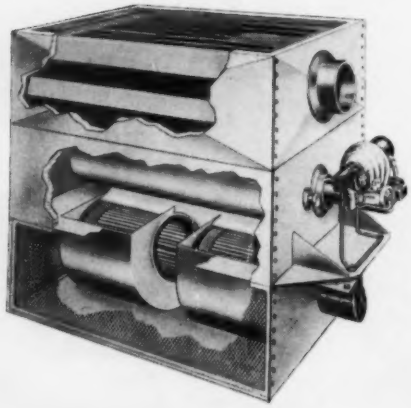
Campbell

# WARM AIR HEATERS FOR LARGE BUILDINGS

Municipal Building, Bettendorf, Iowa, heated and cooled with a Campbell U-700 Hi-Boy combination heating-cooling unit. Heater is gas-fired. Architect-Engineer, Louis C. Kingscott and Assoc., Inc., Davenport, Iowa and Kalamazoo, Mich. Heating contractor, F. W. Lodge Heating Co., Inc., Davenport.

# LOW COST, YEAR-ROUND COMFORT

It's easy to combine heating and summer air conditioning when you install a Campbell Warm Air Heater. Campbell units make full use of all the natural advantages of warm air heating. Fast heat delivery, positive control of temperature, humidity and ventilation, with exceptional fuel economy. Quiet Campbell Blower units have ample capacity to assure efficient delivery of either heated or cooled air. Your inquiry will receive prompt attention.



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**We have some attractive openings for men calling on heating contractors and architects.**

**CAMPBELL HEATING COMPANY**

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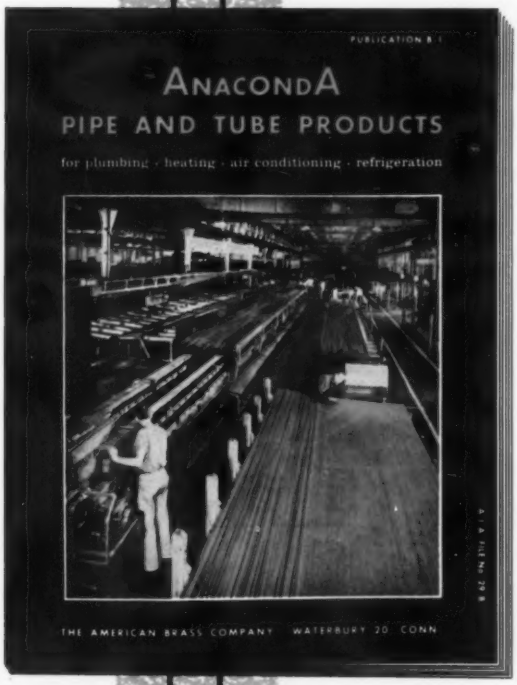
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for specifiers and installers who are seeking the best available information on brass and copper pipe and copper tube

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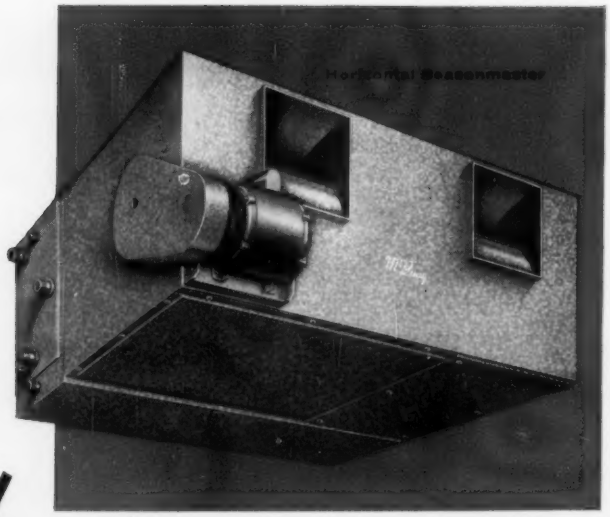


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**NEW single and multi-zone central station air conditioning units**

## SAVE valuable SPACE

Compactness saves space, and McQuay proudly offers a new line of quality engineered central station air conditioning units that do just that. A new space saving design, available in both single zone draw through and multi zone, or double duct, blow through arrangements in low pressure (up to 3″ s.p.) and medium pressure (3″ to 5½″ s.p.) makes the McQuay line the most complete and versatile in the industry. Thirteen single zone and eleven multi zone models are available. See the McQuay representative in or near your city, or write for catalog 560 to McQuay, Inc., 1601 Broadway N. E., Minneapolis 13, Minnesota.

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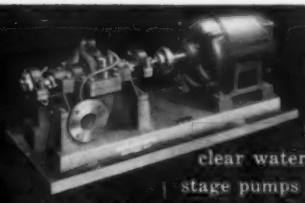
AIR CONDITIONING • HEATING • REFRIGERATION

***Clear Water Pumps*** — Double suction pumps designed for utmost efficiency in clear water service. Ruggedly built for dependability, minimum maintenance and down time. Send for Bulletin 955.



***High Pressure Pumps*** — Ideal for boiler feed and other severe clear water service. These multi-stage pumps operate against heads to 1500 ft. Capacities to 900 gpm. For complete facts, write for Bulletin 980.

***Close-Coupled Pumps*** — These efficient pumps save space, simplify installation. No need for shaft alignment. Vertical or horizontal models. Adjustable discharge angle. Write for Bulletin 975.

***NEW! 'Buffalo' Hermetic Pumps*** — Quality pumps with special bearings for use where leakage would be dangerous or costly. Available in a broad range of materials of construction. Write for full details.

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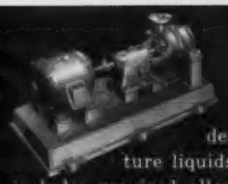
# GPL*



***Heat Transfer Pumps*** — These special 'Buffalo' Pumps are designed to handle high temperature liquids. Job-engineered construction includes required alloys, water-cooled bearings and proper packings. Single suction, solid shell design gives peak efficiency. Write for complete details.

*** True long-range pump economy depends on GPL (Gallons Per Lifetime)...pumped day-in-and-day-out with a minimum of down-time and maintenance costs. This is the kind of long-lived reliability built into every 'Buffalo' Pump. It is the most important result of top quality design and construction.**

'Buffalo' offers a complete line of centrifugal pumps featuring parts interchangeability and low maintenance. Whatever your liquid moving needs, chances are there's a 'Buffalo' Pump to fit it perfectly. And your 'Buffalo' resident engineer is the man to recommend it. Contact him, or write us direct.

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*'Buffalo' Air Handling Equipment to move, heat, cool, dehumidify and clean air and other gases.*

*'Buffalo' Machine Tools to drill, punch, shear, bend, slit, notch and cope for production or plant maintenance.*

*'Buffalo' Centrifugal Pumps to handle most liquids and slurries under a variety of conditions.*

*Squier Machinery to process sugar cane, coffee and rice. Special processing machinery for chemicals.*

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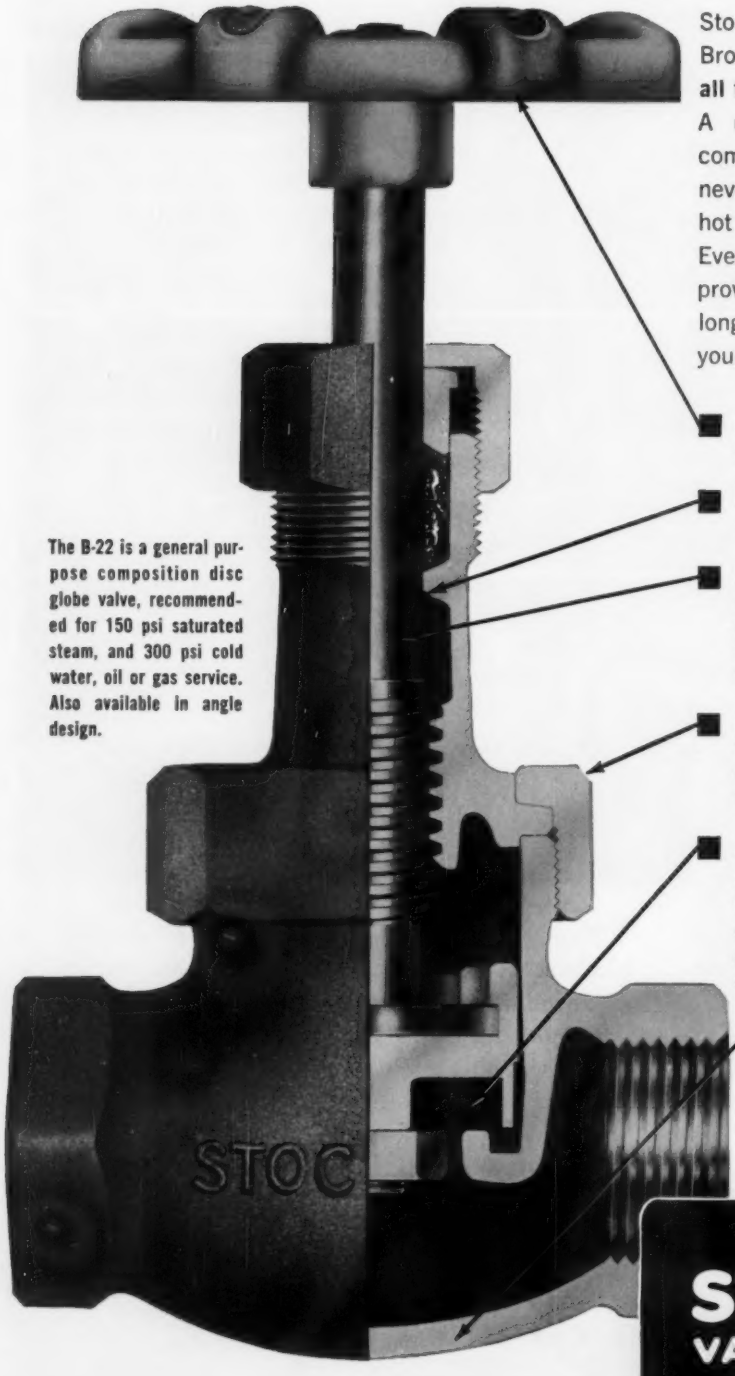


**The B-22 is a general purpose composition disc globe valve, recommended for 150 psi saturated steam, and 300 psi cold water, oil or gas service. Also available in angle design.**

Stockham's B-22 150 lb. Composition Disc Bronze Globe Valve puts an end **once and for all** to disc misapplications and valve failures. A unique, specially-developed, all-purpose composition disc material provides positive, never-fail control for **six services**—cold water, hot water, steam, oil, gas and compressed air. Every **other** feature of the B-22 has been proved far superior to other globe valves for long, dependable, trouble-free service. See for yourself . . .

### HANDWHEEL
Easy grip, non-slip, non-heating design.

### REPACKING SEAT
Can be repacked under pressure when fully open.

### BESTALOY STEM
Extra large diameter for added strength. Extra length stem threads give complete engagement for longer stem life. "Bestaloy" has a minimum tensile strength of 85,000 psi.

### UNION BONNET
Three-piece union bonnet design allows the valve to be reassembled easily and repeatedly without injury to body-bonnet bearing surfaces.

### ALL PURPOSE COMPOSITION DISC
This one disc controls cold water, hot water, steam, oil, gas and compressed air. Slip-on type disc holder is guided throughout travel for perfect alignment.

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# THESE FIGURES tell the STORY

## ...on underground insulated piping systems!!

| TYPE OF SYSTEM | % OF NATIONAL PURCHASES IN 1960 |
|---|---|
| AIR TESTABLE | 93½% |
| FILL-TYPE | 6½% |

**New... Cost Report**

This Insulation Efficiency Cost Report shows how a small efficiency loss can cost you over $2,000.00 a month in higher heating bills . . .

Ninety-Three percent of the people responsible for specifying underground distribution piping overwhelmingly choose an air-testable system. These figures tell the story and are based on actual orders placed. What's the answer! . . . AN INSTALLED 15 LB. PRESSURE TEST. It offers assurance of a tight, leak-proof system. In short . . . if air cannot escape . . . surface water cannot get in . . .

Write for illustrated catalog and if you do not have our new cost report . . . ask for a copy along with the catalog.

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# Original specification of FOAMGLAS® Stay-Dry Pipe Insulation would have eliminated this costly replacement project

Digging out "buried" building piping to replace wet insulation or rusted hangers is an expensive, messy operation. Only FOAMGLAS Stay-Dry Pipe Insulation eliminates moisture problems and gives complete piping protection for the life of the installation.

Other insulations will gradually absorb moisture until problems develop—water accumulates and drips; grows into a costly trouble spot on the ceiling. FOAMGLAS Stay-Dry, however, is composed of completely closed glass cells that remain impervious to water or vapor of any kind. Condensation doesn't form; hangers won't rust. And its rigidity prevents insulation sag on vertical runs, eliminates compression at hanger points.

FOAMGLAS Stay-Dry Pipe Insulation, available in a complete range of sizes and fittings, is easy to apply, easy to cut and fit right on the job. You'll find it suitable for ice water lines, chilled water lines, low pressure steam lines, hot water and dual temperature lines.

Write for our new bulletin on FOAMGLAS Stay-Dry Pipe Insulation. It contains user stories, physical properties, data and specifications. Pittsburgh Corning Corporation, Department HP-71, One Gateway Center, Pittsburgh 22, Pa.

PITTSBURGH
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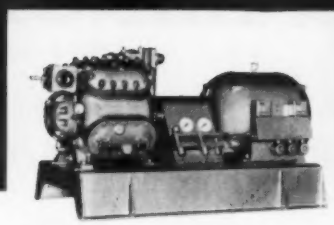
CORNING

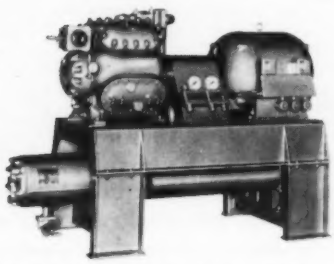
# M-PAK*

**MODULAR REFRIGERATION AND AIR CONDITIONING UNITS INCREASE AVAILABILITY... SPEED-UP DELIVERY**

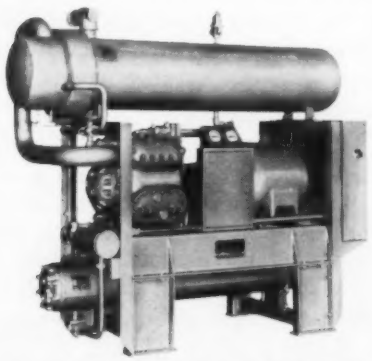
*Modular Packages



B&G Compressor plus B&G Motor becomes a B&G Motor Compressor.



B&G Motor Compressor plus B&G Condenser and base becomes a B&G Condensing Unit.



B&G Condensing Unit plus B&G Evaporator and Control System becomes a B&G Package Liquid Cooler.

In its M-Pak Modular Packages, B&G presents a new advance in efficiency designing of air conditioning and refrigeration equipment. M-Pak units are built around five basic sizes of open-type compressors. Factory-stocked motors, condensers, evaporators and controls can be added to these basic units to make a comprehensive line of "packages" of from 7½ to 150 tons.

For example, motor compressors are produced by adding a B&G-built motor to a B&G basic compressor. Further addition of a B&G condenser and a standard base makes a condensing unit.

All major components of M-Pak units are designed, manufactured, and guaranteed by B&G...*one* responsibility for the entire package. This, we believe, is an exclusive feature.

B&G also makes a complete line of refrigeration and air conditioning evaporators, condensers and centrifugal pumps—with many commonly used sizes available for immediate shipment from factory stock.

**Send today for complete engineering and selection data on Bell & Gossett M-Pak* refrigeration and air conditioning units.**

**BELL & GOSSETT**
**COMPANY**

**Dept. RGS-5, Morton Grove, Illinois**

*Canadian Licensee: S. A. Armstrong, Ltd., 1400 O'Connor Drive, Toronto 16, Ontario*

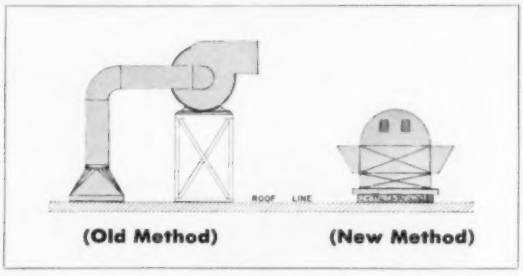
PENN
TAKES
the
HEAT
OFF
with a new
solution
to an
old problem

FUMES *and* ODORS *from interior "hot spots" can now be discharged* UP & AWAY *with the*

# PENN RANGEX

*POWER ROOF EXHAUSTER*

designed for *ALL TYPES* of buildings where ovens, hearths and ranges are used!




A major innovation for ventilating heat producing equipment in schools, institutions, foundries and restaurants is the Penn Rangex, the first centrifugal roof exhauster designed and engineered to throw fumes, odors and gasses *high into the air!*

A unique design of the Rangex power exhauster is its "Up & Away" discharge that dissipates offensive and undesirable heat and odors from range hoods, dishwashers, industrial ovens, charcoal pits and open hearths . . . clearing the air outside as well as inside.

With the Rangex there's no unsightly build-up as with utility sets . . . fumes blown upward can't stain the roof or re-enter through windows or roof intakes. Most important, the Rangex reduces flammable grease accumulation on the roof by exhausting fumes high into the air and away from the building.

To learn how the Rangex can help you solve thorny ventilating problems that exist in almost every major building, send today for Bulletin RGX-60.

PVC

**PENN VENTILATOR CO., Inc.**
PHILADELPHIA 40, PENNA.

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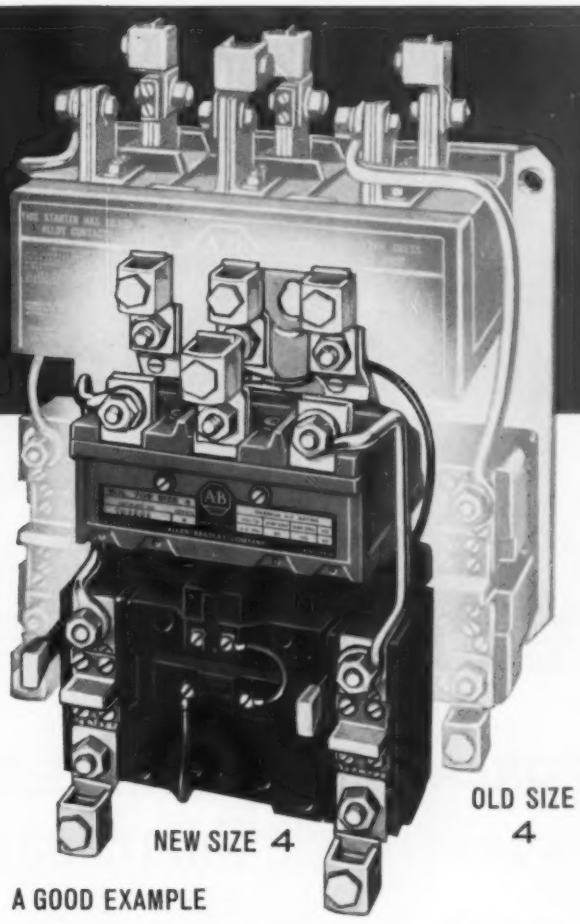
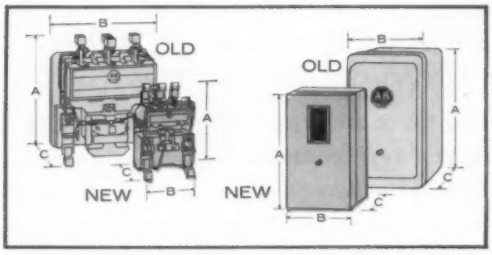
# You get BIGGER PERFORMANCE




A GOOD EXAMPLE

# Plus SMALLER SIZE

## with the new Allen-Bradley Bulletin 709 Starters




The new revolutionary Bulletin 709 motor starters are surprisingly small in size—yet, they are good for many more millions of operations—without trouble or maintenance! Rating for rating, they have no equal. They are today's best starter value—and they cost no more!

The "Quality" you've come to expect in all Allen-Bradley control is represented in all details—especially in the "eye appealing" enclosures styled by the world famous industrial designer, Brooks Stevens. Write today for details of the new Bulletin 709 line—the greatest advance in motor control in 30 years: *Allen-Bradley Co., 1335 South First Street, Milwaukee 4, Wisconsin.*

**Check These New SPACE-SAVING Dimensions**

| Starter Size | OPEN TYPE STARTERS | | | | | | NEMA 1 ENCLOSURES | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Height A | | Width B | | Depth C | | Height A | | Width B | | Depth C | |
| | NEW | OLD | NEW | OLD | NEW | OLD | NEW | OLD | NEW | OLD | NEW | OLD |
| 00 | 3⅜ | — | 3⅜ | — | 3⅜ | — | 7⅝ | — | 4⅞ | — | 4¼ | — |
| 0 | 5⅞ | 5⅝ | 4 1/16 | 4¾ | 3 1/16 | 3¼ | 9⅛ | 7⅞ | 6 5/16 | 5⅝ | 4⅜ | 4¼ |
| 1 | 6⅝ | 5⅞ | 4½ | 5 | 3 1/16 | 3¼ | 10 | 8 3/16 | 6 1/16 | 6⅜ | 4⅜ | 4¼ |
| 2 | 7⅝ | 10 1/16 | 4⅝ | 5¾ | 3 1/16 | 4 7/32 | 12 | 14½ | 7⅝ | 9 | 4⅜ | 5 7/16 |
| 3 | 10¼ | 12⅝ | 6¼ | 7¼ | 5 7/16 | 5 7/16 | 16⅝ | 19½ | 10⅜ | 11⅜ | 7 | 6 1/16 |
| 4 | 11 7/16 | 16¼ | 7 5/16 | 12¾ | 6¼ | 6 1/16 | 22 | 26 9/16 | 11⅝ | 14 3/16 | 8 | 7 1/16 |
| 5 | 14 1/16 | 20 | 9 | 16⅛ | 6½ | 8¾ | 32 3/16 | 41½ | 17 3/16 | 19 9/16 | 9⅞ | 13 9/16 |

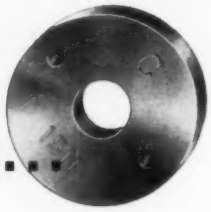
# ALLEN-BRADLEY

Member of NEMA

QUALITY MOTOR CONTROL

# Peak Coil Performance

## when you buy SPORLAN Refrigerant Distributors with the Versatile Interchangeable Nozzle...



*The distributor nozzle orifice is the key factor in creating the necessary velocity and turbulence to maintain a homogeneous mixture of liquid and vapor for equal distribution to all circuits of the evaporator.*

*Provides the desired flexibility to handle variations in evaporator applications . . . changes in load, temperature and refrigerants.*

*Distributor may be installed in any position.*

*Permits simplified inspection of solder joints and connecting tubing from distributor to evaporator.*

*Sporlan Refrigerant Distributors available in any combination of circuits and capacities . . . flare, sweat or flange connections . . . brass, steel or aluminum bodies.*

***And only the Sporlan line offers brass body distributors with auxiliary side connections developed especially for hot gas defrost, hot gas by-pass and reverse cycle (heat pump) applications.***

**Get all the facts,** *write for Bulletin 20-10.*

**SPORLAN VALVE COMPANY**
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EXPORT DEPT. 85 BROAD STREET NEW YORK 4, N. Y.

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## TO MANUFACTURE
## TO DEVELOP

## completely self-contained air conditioning units

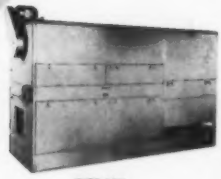
GOVERNAIR CORPORATION

. . . began the manufacture of the first completely self-contained commercial type air conditioning units in 1937. Development has been continuous since that time, and Governair now manufactures packaged air conditioning units, for both commercial and industrial application, in the widest range of capacities available in the industry.

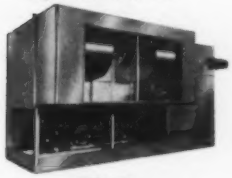
Governair Corporation also constantly recognizes the importance of producing a high quality, completely flexible system to benefit the end user best. Production facilities are tailored to accomplish these ends economically. This, in turn, makes the Governair prices highly competitive, even though only the finest components are used in the assembly.

Development of the larger tonnage units has made available the economy of installation and reliability of a factory balanced and tested package system . . . for even the largest industrial requirements. Single units of 120 ton capacity are being fabricated regularly — and to the exact specifications of the customer.

**GOVERNAIR CORPORATION**
4840 NORTH SEWELL
OKLAHOMA CITY, OKLAHOMA

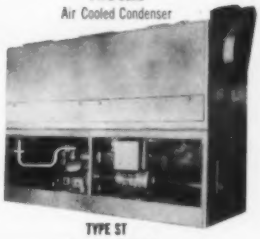


**TYPE SCU**
Evaporative Condenser Model



**TYPE SCMZ**
Complete Multi-Zone Package

**TYPE SCAC**
Air Cooled Condenser



**TYPE ST**
Water Cooled Model

**TYPE STMZ**
Water Cooled Multi-Zone

**GOVERNAIR**

Write for detailed information, or consult your yellow page directory for the name of our local representative.

# SOURCE

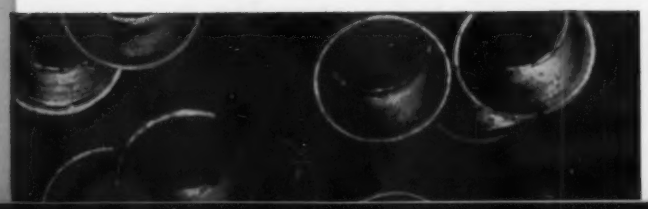
## 900 leading pipe distributors are your reliable source for quality steel pipe from Youngstown

Youngstown steel pipe is a huge inventory of kinds and sizes in 900 pipe distributor warehouses. It's a hurry phone order rushed right to your job site.

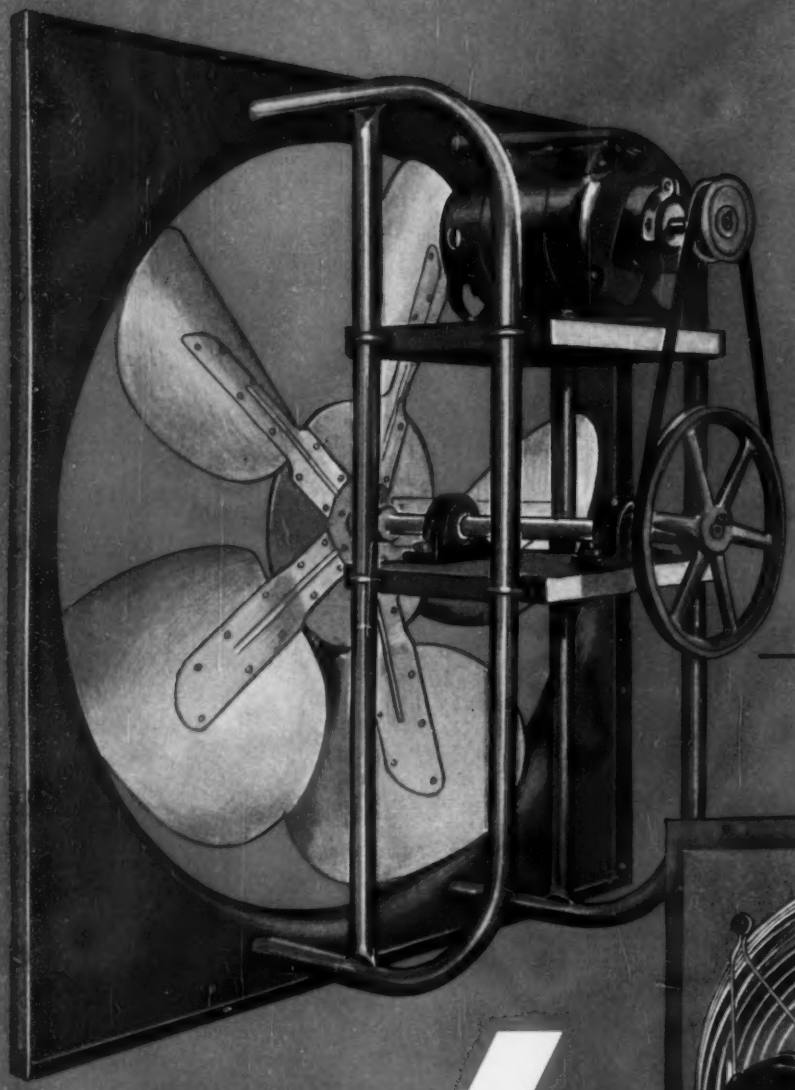
Youngstown steel pipe is continuous weld, electric weld, or seamless. Choose it in all standard steel specifications or corrosion resistant Yoloy steel. Get it black or galvanized, standard weight, extra strong, double extra strong, large O.D. Bend it, weld it, thread it. Install it quickly, install it easily using standard pipe installation practices.

Youngstown steel pipe is sold through pipe distributors. More than 900 of them across the nation. They are the leading pipe distributors of every community. You know them. Call them. Count on them to cut, thread, mix, and deliver Youngstown steel pipe fast, in the size and grade you need. Depend on their service. Depend on their stocks. They're your sure source for Youngstown pipe.

**Youngstown – growing force in steel**



For full information about Youngstown Steel Pipe, write: Dept. 19B;
**The Youngstown Sheet and Tube Company, Youngstown, Ohio**



# PROPELLER FANS

EXHAUST

AND

SUPPLY

SEND FOR
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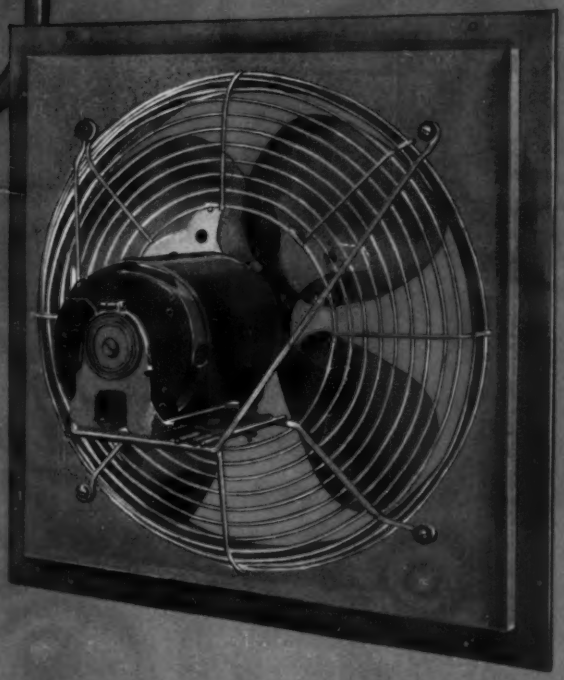

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**NEW from *Walker*,**
**SAVES AND SERVES ALL FUELS!**
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**CONVERTS QUICKLY FROM SINGLE TO DOUBLE ACTION!**
Just remove wing nut and bolt.

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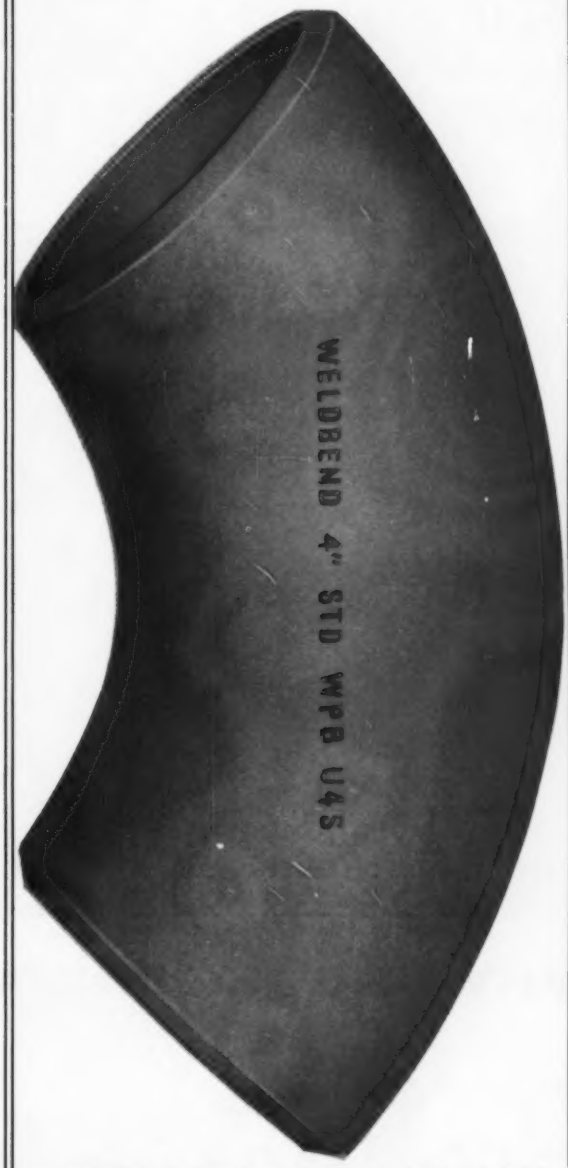
# WELDBENDS

The Newest Name in Weld Fittings




- **WELDBEND Fittings meet *all* ASTM A-234 and *all* ASA B16.9 specifications.**
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**WELDBEND TUBULAR PRODUCTS CO.**
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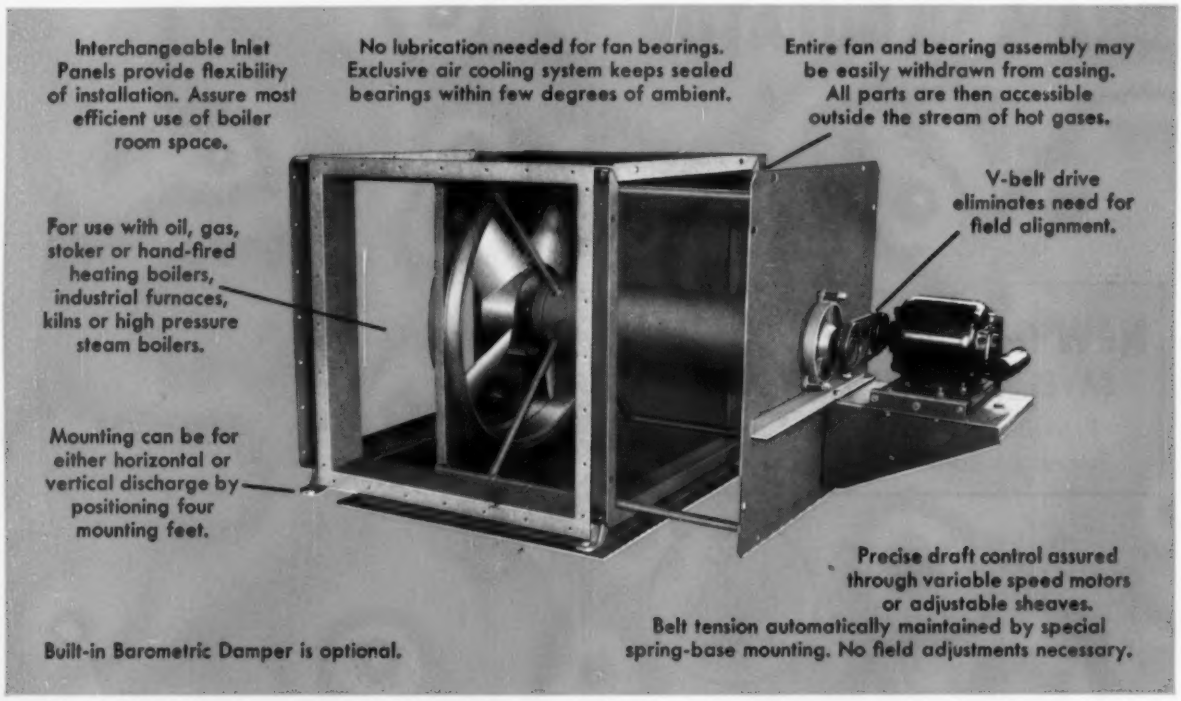
**Phone LUdlow 2-3500**

# WHY USE DRAFT INDUCERS?

## Because:

- Draft inducers permit the use of short stub stacks eliminating the costs and unreliable operation of tall stacks.
- Draft inducers maintain slightly negative in-boiler pressure which prevents gas or fumes leaking into the boiler room.
- In small unattended boilers, draft inducers minimize the danger of gas accumulations or blowouts.
- Draft inducers, by providing uniform draft at all times, permit closer adjustment of burners than would be possible otherwise for complete and economical combustion.


Interchangeable Inlet Panels provide flexibility of installation. Assure most efficient use of boiler room space.
No lubrication needed for fan bearings. Exclusive air cooling system keeps sealed bearings within few degrees of ambient.
Entire fan and bearing assembly may be easily withdrawn from casing. All parts are then accessible outside the stream of hot gases.
V-belt drive eliminates need for field alignment.
For use with oil, gas, stoker or hand-fired heating boilers, industrial furnaces, kilns or high pressure steam boilers.
Mounting can be for either horizontal or vertical discharge by positioning four mounting feet.
Precise draft control assured through variable speed motors or adjustable sheaves.
Belt tension automatically maintained by special spring-base mounting. No field adjustments necessary.
Built-in Barometric Damper is optional.

# WHY CHOOSE WING DRAFT INDUCERS?

## Because:

- Wing Draft Inducers take far less room and are much easier to install in any position than centrifugal units.
- Wing Draft Inducers have led the field for over ten years.
- Wing's experience guarantees a draft inducer that is constructed to provide really long and trouble-free life.
- Wing Draft Inducers provide the unique, easy-access feature. The fan and drive equipment may be withdrawn from the housing for cleaning and maintenance without disturbing breeching connections.

WING

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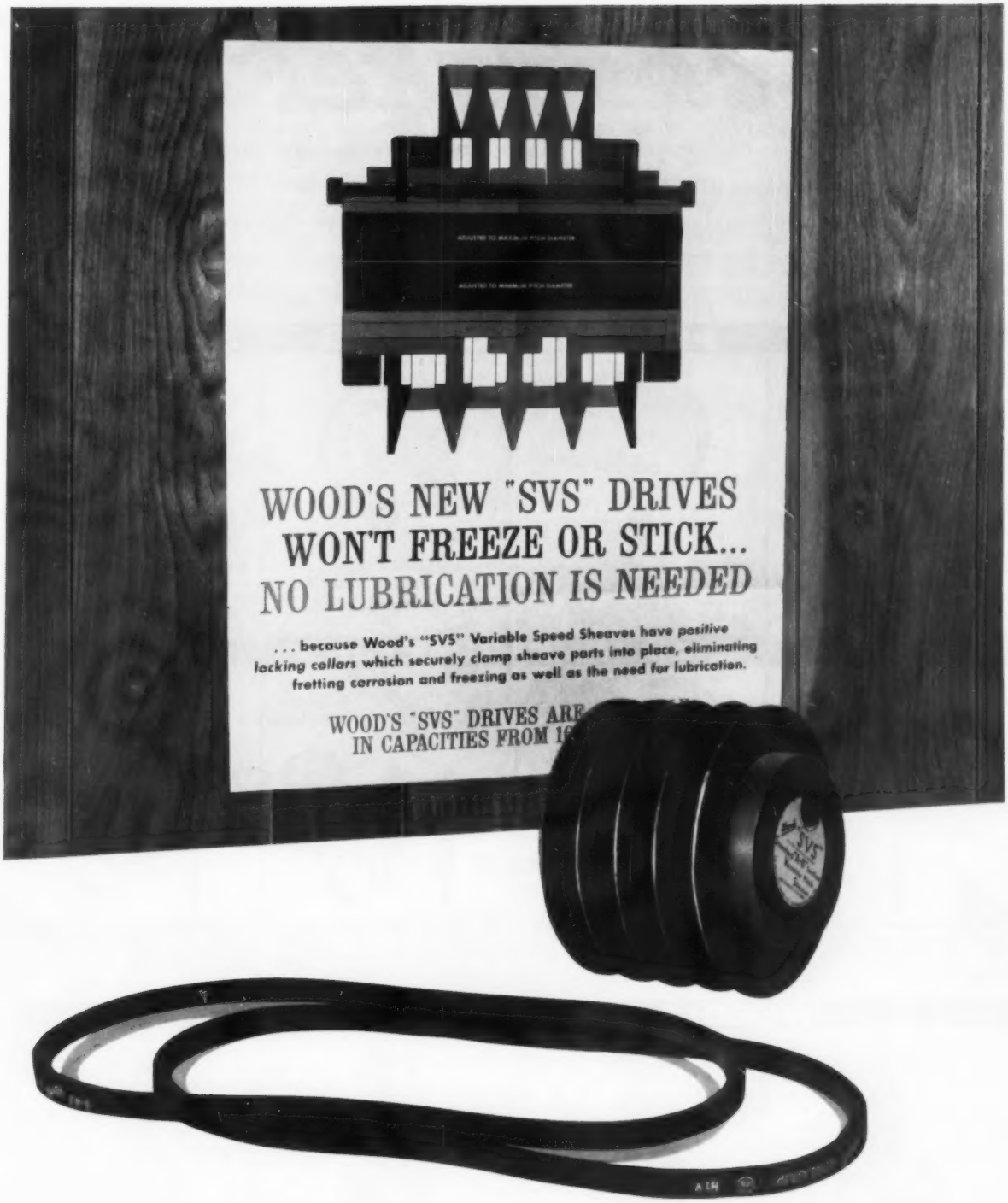
DIVISION OF AERO-FLOW DYNAMICS, INC.
LINDEN, NEW JERSEY
FACTORIES: LINDEN, N. J. AND MONTREAL, CANADA

WC 140


WOOD'S NEW "SVS" DRIVES
WON'T FREEZE OR STICK...
NO LUBRICATION IS NEEDED
... because Wood's "SVS" Variable Speed Sheaves have positive locking collars which securely clamp sheave parts into place, eliminating fretting corrosion and freezing as well as the need for lubrication.
WOOD'S "SVS" DRIVES ARE
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**Wood's stationary control, variable speed drives, including SVS types, are available in capacities from fractional to over 300 hp using conventional v-belts. Wide range VPS types are available in capacities from 1 to 20 hp.**

Write for BULLETIN 6102.

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Wood's

SVS/161

# Marsh Makes It!

***If it's a pressure gauge, dial thermometer, or needle valve, Marsh makes it***...makes it in every form to suit every need...makes it better in the opinion of thousands of discriminating users. Only a few key products are illustrated here, but hundreds are described in Marsh Catalogs. Ask for information covering the product or products in which you are interested.

## PRESSURE GAUGES

**"Mastergauge"**—the world's most effective pressure gauge for extreme service.

**"Master-test"**—"Mastergauge" quality in a gauge for services requiring high accuracy.

**Quality series**—second only to "Mastergauge" and "Master-test" for tough conditions.

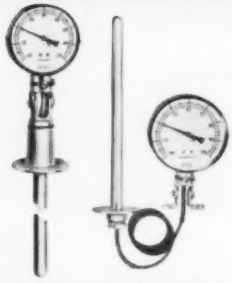
**Standard series**—best moderate-priced gauge for run-of-plant conditions.

## DIAL THERMOMETERS

**Vapor tension thermometers**—direct mounted type. Many sizes; ranges.

**Distant reading thermometers**—vapor-tension and gas filled types in many sizes; ranges.

**Piping thermometers**—specially designed for piping. Types for all purposes, including distant reading.



**Duct thermometers**—specially designed for all conditions including distant reading.

## NEEDLE THROTTLING VALVES

**Alloy steel**—complete series of sizes and patterns. Pressures up to 10,000 psi.

**416 Stainless steel**—complete series of sizes and patterns in 416 stainless. Pressures up to 10,000 psi.

**316 Stainless steel**—complete series of sizes and patterns in 316 stainless. Pressures up to 6,000 psi.

**Panel mounted**—all valves—alloy steel, 416 stainless, and 316 stainless—available in panel mounted types.

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**MARSH INSTRUMENT COMPANY, Dept. T, Skokie, Ill.**
*Division of Colorado Oil and Gas Corporation*
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Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas.
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U. S. Flexible Metallic Tubing Co.
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# KEFLEX QUADRA-SIDE EXPANSION COMPENSATORS

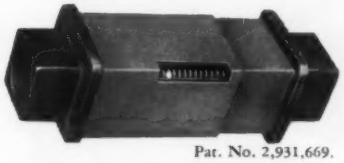
## FOR STEAM AND HOT WATER HEATING SYSTEMS USED WITH CONVECTOR AND FIN TUBE BASEBOARD RADIATION UNITS IN SCHOOLS, HOSPITALS, OFFICES AND COMMERCIAL INSTALLATIONS

**TYPE 7 Q** square brass telescoping case protects laminated stainless steel bellows from torsion, squirm, misalignment and external damage. Compensators are used in high and low pressure hot water supply lines, risers and for baseboard radiation. Extra flexibility provides maximum cyclic life. Units are very compact and rugged. Sizes ¾" thru 3". Pressures to 300 PSI. Temperatures to 800°F. Traverse: Single Units, total 2" (1-½" compression, ½" extension) Dual units available.

**TYPE 11 Q-T** has heavy square telescoping case and laminated stainless steel bellows. For use in risers and with baseboard radiation. Test pressure 150 PSI, working pressure 100 PSI, temperatures to 300°F. Traverse: Total 1" (¾" compression, ¼" extension).

### TYPE 7 Q WITH BRASS FEMALE THREADED ENDS

Working Pres. 300 PSI Maximum
Temp. 800 F

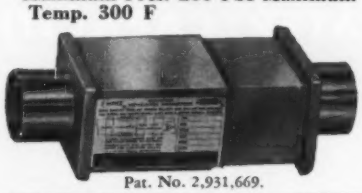


Pat. No. 2,931,669.

| Nom. I.P.S. | Overall Length | Max. O.D. | Wt. # |
|---|---|---|---|
| ¼"-1.00"-1.25" | 6.50" | 2.00" | 2 |
| 1.50 | 6.50 | 2.50 | 4 |
| 2.00 | 6.50 | 3.00 | 5 |
| 2.50 | 6.50 | 3.50 | 6 |
| 3.00 | 6.50 | 4.00 | 9 |

### TYPE 7 Q-T WITH COPPER TUBE ENDS

Maximum Pres. 200 PSI Maximum
Temp. 300 F



Pat. No. 2,931,669.

| To Fit Copper Tubing | | Overall Length | Max. O.D. | Wt. # |
|---|---|---|---|---|
| Nominal I.D. | Actual O.D. | | | |
| ¼" | ⅞" | 6.50" | 2.00" | 1½ |
| 1 | 1⅛ | 6.50 | 2.00 | 1½ |
| 1¼ | 1⅜ | 6.50 | 2.00 | 1½ |
| 1½ | 1⅝ | 9.00 | 2.50 | 3½ |
| 2 | 2⅛ | 10.00 | 3.00 | 4½ |
| 2½ | 2⅝ | 10.75 | 3.50 | 5½ |
| 3 | 3⅛ | 11.50 | 4.00 | 8¼ |

### TYPE 11 Q-T WITH COPPER TUBE ENDS

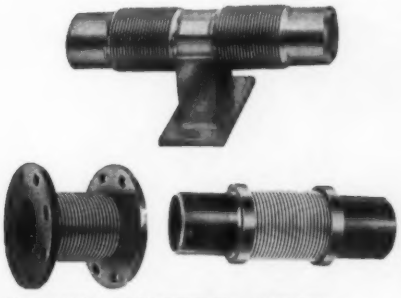
Maximum Pres. 100 PSI Maximum
Temp. 300 F

Pat. No. 2,931,669.

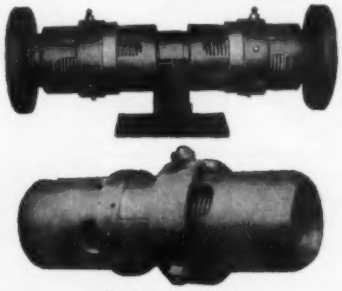
| To Fit Copper Tubing | | Overall Length | Max. O.D. | # |
|---|---|---|---|---|
| Normal I.D. | Actual O.D. | | | |
| ¼" | ⅞" | 4.50" | 1.50" | 1¼ |
| 1 | 1⅛ | 4.50 | 1.50 | 1¼ |
| 1¼ | 1⅜ | 4.50 | 1.75 | 1½ |
| 1½ | 1⅝ | 4.50 | 2.25 | 3 |
| 2 | 2⅛ | 4.50 | 2.75 | 4 |

## EXPANSION JOINTS—VIBRATION ABSORBERS—FLEXIBLE CONNECTORS—PIPE GUIDES

### Force Required to Compress Keflex Expansion Joints Their Full Rated Traverse is Usually Less Than 100 Lbs., Total

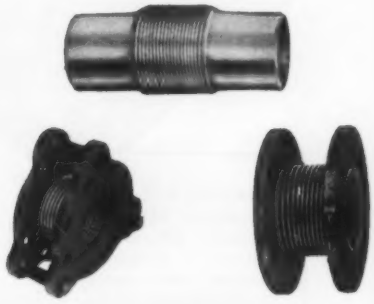


**KEFLEX EXPANSION JOINTS** — corrugated, packless type for steam and hot water heating systems and process piping. Laminated stainless steel bellows with internal liner guides and stainless steel contour control rings. Weld ends, or flanges. Outside shrouds and intermediate anchor bases available. Sizes 2" through 48". Pressures 70 to 450 PSI. Temperatures to 800° F. Furnished for various required traverses.



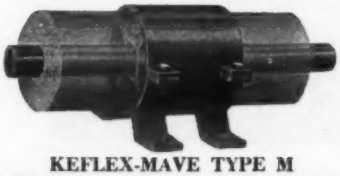
Pat. No. 2,958,550

**KEFLEX-KETROL CONTROLLED EXPANSION JOINTS** — positive protection against torsion. For use in pipe lines to compensate for expansion and contraction. Shroud has intermeshing fingers providing concentric guiding and protection against squirm, torsion, and external damage to laminated stainless steel bellows. Designed for high pressure, high temperature hot water service. Movement is controlled by limit stops. Sizes 2" through 48". Pressures to 450 PSI and temperatures to 800° F.



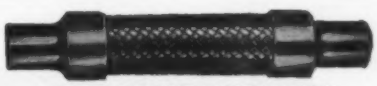
**KEFLEX FLEXIBLE CONNECTORS AND VIBRATION ABSORBERS** — to absorb vibration from pumps, chillers, and compressors. Serves to relieve stress on pump volute when piping is misaligned. Extra flexibility of laminated stainless steel construction produces long cyclic life. Compact units save space and are easy to install. Available with or without tie rods. Sizes 2" through 48". Pressures to 450 PSI and temperatures to 800° F.

Modified Types are available for special conditions requiring hig her pressure, temperatures, traverse, or combination deflections.



**KEFLEX-MAVE TYPE M**
Fabricated steel pipe guides for concentric guiding of pipe lines. Special insulated guides are available for chilled water.

**FLEXIBLE "BMH" CONNECTORS**

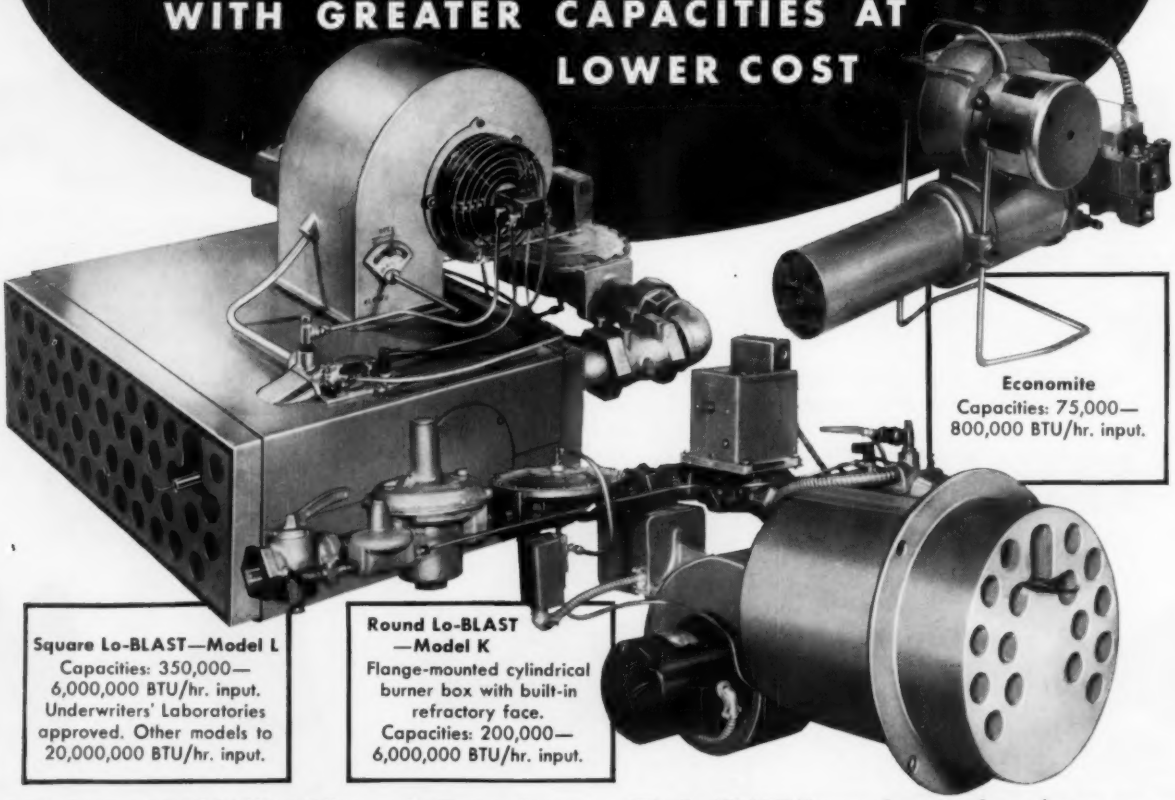


**"USF" BRONZE VIBRATION ABSORBERS**

Braided bronze Metal Hose assemblies made in standard lengths. Usually used as flexible connectors on pumps and other mechanical equipment for heating and air conditioning service. Available with threaded male ends, flanges, and copper tube sweat ends.

# LO-BLAST AND ECONOMITE

## POWER GAS BURNERS NOW AVAILABLE IN NEW ADVANCED DESIGNS... WITH GREATER CAPACITIES AT LOWER COST



**Economite**
Capacities: 75,000—800,000 BTU/hr. input.

**Square Lo-BLAST—Model L**
Capacities: 350,000—6,000,000 BTU/hr. input. Underwriters' Laboratories approved. Other models to 20,000,000 BTU/hr. input.

**Round Lo-BLAST —Model K**
Flange-mounted cylindrical burner box with built-in refractory face. Capacities: 200,000—6,000,000 BTU/hr. input.

Over the years Lo-BLAST and Economite Power Gas Burners have established a solid reputation for dependable, low-cost operation. Now complete re-designing to add new engineering features to the tried and proved Lo-BLAST principles and to permit improved manufacturing methods has resulted in a *lower cost per BTU of capacity!*

Both burners save money because they eliminate the fuel waste caused by uncontrolled draft. A power-type burner provides a constant, metered supply of both air and gas independent of varying draft conditions. Perfect combustion at all times is the result, *with savings up to 10%!*

The Lo-BLAST Burner does not depend upon natural draft, but upon air supplied by a small, *quiet* blower. It provides both primary and secondary combustion air *only when the burner is on.* When the burner shuts off, the flow of air shuts off. The heating plant thus retains much of its heat between operations.

Lo-BLAST Burners eliminate the need for high chimneys—"inshot" design and complete factory assembly reduce installation and maintenance costs. Each unit is factory-tested on gas before shipment.

**Whatever you heat, you can do it for less with Lo-BLAST!**

***Send for descriptive literature and engineering data.***

**MID-CONTINENT METAL PRODUCTS COMPANY**

2717 N. Greenview Avenue • Chicago 14, Illinois

YARWAY news briefs

*from* **Yarnall-Waring Company,** *Philadelphia 18, Pa.*
*BRANCH OFFICES IN 19 UNITED STATES CITIES • SALES REPRESENTATIVES THROUGHOUT THE WORLD*

# YARWAY GUN-PAKT EXPANSION JOINTS ARE BEING SPECIFIED IN RECORD NUMBERS

## These user-benefits tell why:

All over the country a rapidly-increasing number of expansion joint jobs on steam and high temperature water piping at utilities, industrial plants and institutions are being specified "YARWAY GUN-PAKT." Here's why:

**TROUBLE-FREE SERVICE**
Shutdowns are eliminated. Packing can be added *under full line pressure.* No vents. Joints never need repacking.

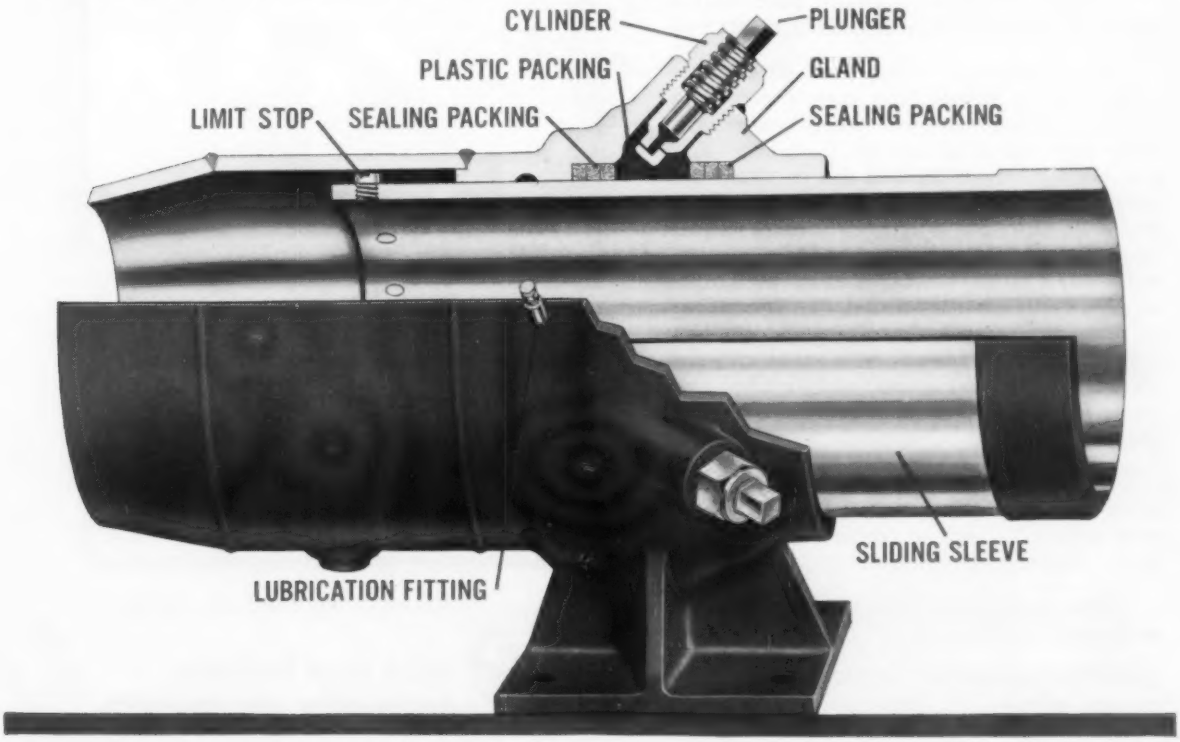
**SIMPLIFIED DESIGN**
Sectioned view (below) shows at a glance the simple, compact design. Provides easy accessibility, takes less space to install and maintain, needs smaller manholes, fewer joints per length of pipeline.

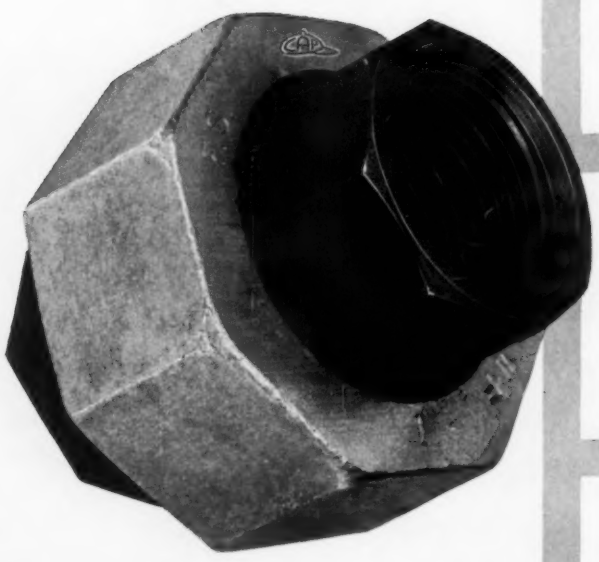
**RUGGED DEPENDABILITY**
All-steel construction, with durable, chromium-plated seamless steel sleeves. *No chance of metal fatigue.*

**INTERNAL AND EXTERNAL GUIDES**
Positive alignment of sleeve in stuffing box, *where it counts.*

**MINIMUM MAINTENANCE**
*Never a shutdown for repacking*—and records show an average of one manhour and 65 cents worth of packing added per joint per year. *Many Gun-Pakt Joints have been in service over 25 years with only this nominal maintenance.*

Why don't *you* investigate Yarway Gun-Pakt Joints by calling a Yarway Sales Engineer at one of the 20 Yarway offices located from coast-to-coast—or simply by writing for Bulletin EJ-1917.





# 4-WAY JOB INSURANCE

Capitol forged steel unions have built-in insurance to give 4-way trouble-free service!

(1) *Leak-proof connections* assured because Capitol unions have *more* threads, accurately cut and double-checked according to Army-Navy gauging practice. Both hand-tight and pressure-tight threads are checked, two operations instead of the one required for American Standard gauging. The extra threads mean on-the-job assurance of tight installations. (2) *Positive seating* because each union is individually pressure-tested. (3) *Clean/over-all protection*, each male and female part completely phosphate coated; each nut electro-zinc plated. (4) *Easy wrenching/faster make-up* because all three parts have a definite octagon shape.

You get all 4 important advantages at no extra cost when you specify CAPITOL forged steel unions . . . one of the full-line of Army-Navy gauged forged steel fittings.

Now more than one million in service and not a single failure.

***CAPITOL MANUFACTURING CO.,***
*Division of Harsco Corporation, Columbus, Ohio.*

**1**
**LEAK-PROOF CONNECTIONS**

**2**
**POSITIVE SEATING**

**3**
**CLEAN/OVER-ALL PROTECTION**

**4**
**EASY WRENCHING/FAST MAKE-UP**

**CAPITOL**

SPECIFY CAP FOR ALL FITTINGS

***SOLD ONLY THROUGH RECOGNIZED DISTRIBUTORS***

# In The Lead With Ucon® Refrigerants

***"Fustest with the mostest"*** is UCON IKE's history thus far, as witness the pioneering of the ring-top refrigerant cylinder, introduction of the handwheel cylinder valve, and instant cylinder deposit refunds . . . all important firsts in packaging and convenience.

And being in the lead is something UCON IKE and the friendly folks he represents, firmly intend to *continue.* When you *really* need something, *we'll deliver* – whether it be in packaging conveniences or helpful service.

Our promise: being on our toes to meet *your* every on-the-job refrigerant need.

For the most compact and *convenient* line of refrigerants . . . See your UCON Refrigerants wholesaler.

UCON Refrigerants are manufactured by
**UNION CARBIDE CHEMICALS COMPANY** – Division of Union Carbide Corporation
270 Park Avenue, New York 17, N. Y.

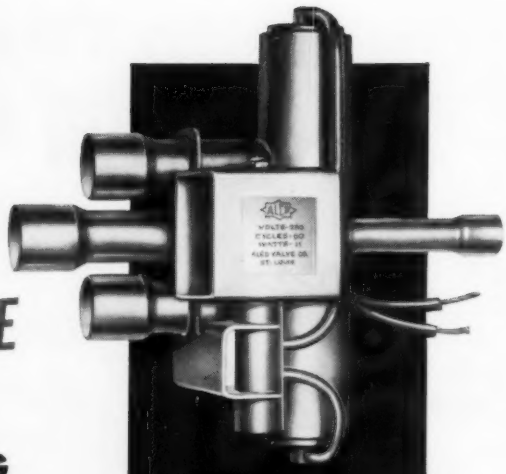
Exclusive Sales Agent to Air Conditioning and Refrigeration Wholesalers
**ANSUL CHEMICAL COMPANY,** Marinette, Wisconsin

UCON is a registered trademark of Union Carbide Corporation

UNION CARBIDE product Ucon® refrigerants — exclusive sales agent ANSUL

# Made by ALCO
## OF CAST IRON AND STEEL
## like a Compressor
## for LONG RELIABLE LIFE

# 4-WAY REVERSING VALVES
*for all reverse cycle systems*



#4WB4-57 Capacities:
2 to 3 tons—Refrigerant 12
3 to 5 tons—Refrigerant 22

#4WB6-79 Capacities:
3 to 5 tons—Refrigerant 12
5 to 7½ tons—Refrigerant 22

## *Features:*

- fine machining and precision honing of cast iron slide and steel outer shell—NO PLASTICS ARE USED.
- operating tests of 300,000 cycles without failure to shift and without loss of tight seating—tests made by independent laboratories.
- shifting (change cycle) while the system is in operation with a 300 PSI differential.
- rapid shifting—to shorten change-over time and therefore shorten defrost cycle.
- the shifting of the valve independent of any pressure drops, and efficient shifting under any combination of operating conditions.
- mounting in any position—except with the pilot valve upside down.

Call your Alco wholesaler—
write for Specifications.

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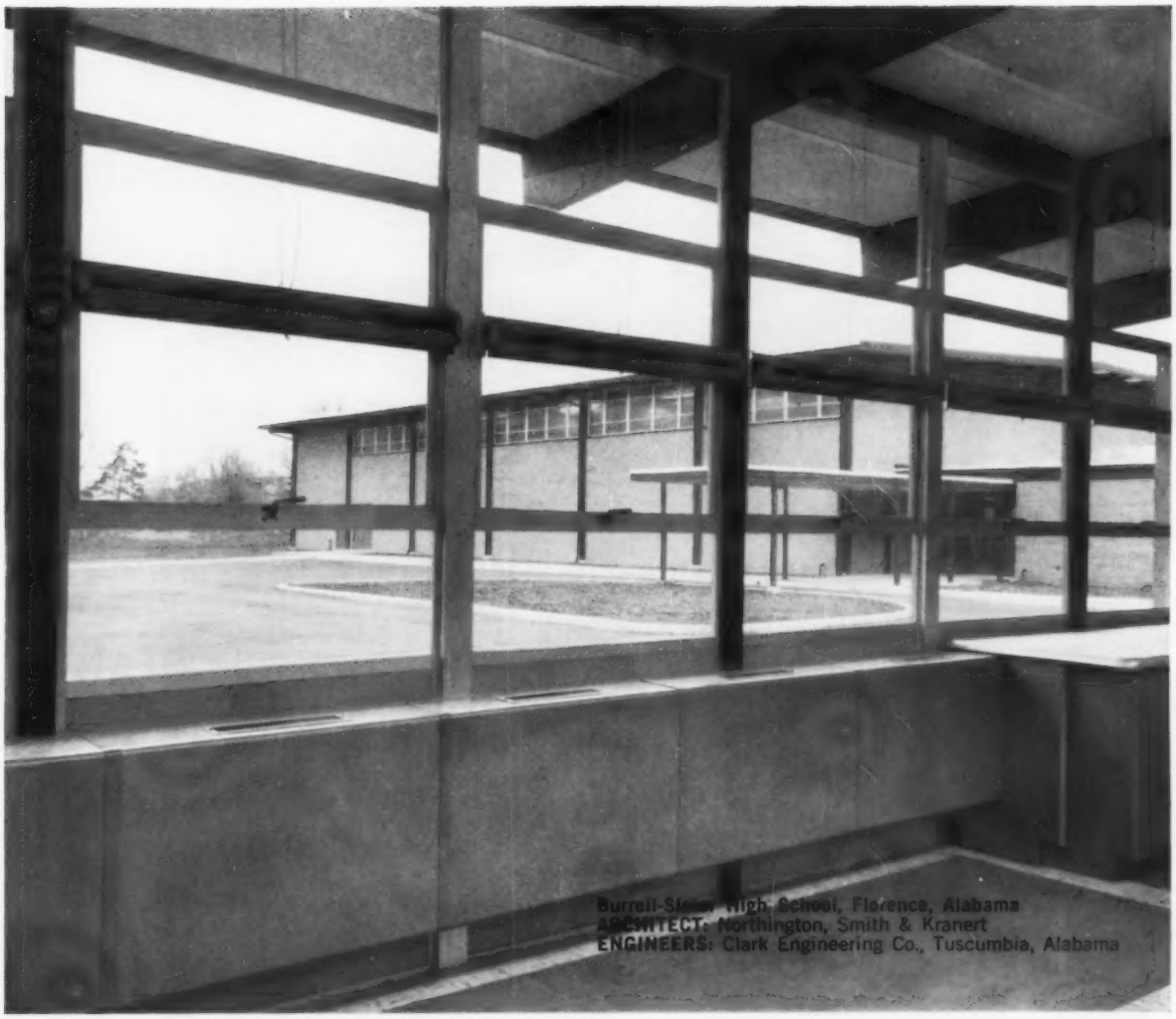
**The one complete line of refrigerant controls:** Thermostatic Expansion Valves • Refrigerant Distributors Solenoid Valves • Suction Line Regulators • Flooded Evaporator Controls and Reversing Valves


Burrell-Sloss High School, Florence, Alabama
ARCHITECT: Northington, Smith & Kranert
ENGINEERS: Clark Engineering Co., Tuscumbia, Alabama

# Total installed cost only 97.8¢ per sq. ft. for NORMAN SCHOOLROOM HEATING AND VENTILATING SYSTEMS in 32-room school

Saving money on first cost is only one of the reasons why school architects, engineers and school administrators are turning to gas-fired Norman Schoolroom Heating and Ventilating Systems. With building costs still rising, Norman individual room-by-room systems are budget-savers. This modern 32-room school is another cost-cutting example.

Nineteen classrooms, gymnasium, auditorium and stage, dining room, library and other areas are efficiently and comfortably heated and ventilated. Yet the building has no pipe tunnels or central heater room . . . no costly network of connecting pipes or ducts.

But most important is the ideal study environment maintained through individual room comfort. Each Norman system evenly distributes fresh outside air blended with recirculated room air *when needed* but conserves fuel during unoccupied periods.

Looking ahead, you can add any number of rooms without touching the existing Norman systems. Air conditioning may be included at time of installation or in the future.

**Want more facts and figures? Send for comprehensive manual on Norman HVS Horizontal or Inn-A-Wal Counter Flow models.**

**Norman® PRODUCTS COMPANY • 1156 Chesapeake Ave., Columbus 12, Ohio**

# NEW

FROM

**bryant**

## GAS-FIRED DUCT HEATERS

**LOW OPERATING COST.** The heat exchanger is engineered for low static pressure... permits moving more cfm per hp.

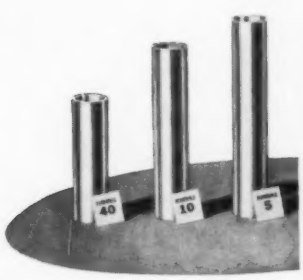
**LONGER LIFE.** The exclusive Tri-Alloy heat exchanger resists corrosion from extreme temperatures, moisture and flue gases.

**COMPLETE LINE.** Single units in eight sizes (50,000 to 250,000 Btu input) and twin units to 500,000 Btu. Matching blower packages — open or enclosed.

**EASY INSTALLATION.** Both flue and controls are readily reversible. For complete information call your local Bryant Distributor or Factory Branch, or write Bryant Manufacturing Company, Indianapolis, Indiana.

# REAL ECONOMY IN PROCESS PIPING IS A MATTER OF SPECIFICATIONS—AND SPEEDLINE FITTINGS!

Make the most of both. First, be sure to check ASA B31.3 for up-to-date pressure-temperature data on critical process applications. This most recent issue of the Code for Pressure Piping certifies the use of light-wall pipe and fittings to a degree not recognized by outdated specifications.




*SPECIFY LIGHT-WALL PIPE and get up to 50% more pipe for your dollar*

**Next, consider the installation advantages of Speedline's improved fittings design to capitalize on light-wall piping savings. Note Speedline's "tangential feature" . . . the extra length of straight on every end of every Speedline Fitting. This extra clearance eliminates alignment problems and speeds welding . . . permits joints to be readily butt-welded, flanged, or socket-welded. You choose the most practical, cost-saving joining method for your application—and one fitting can be used all ways when you specify Speedline Fittings.**

Compute total savings in terms of initial costs *and* ultimate *installed* costs. Light-wall pipe and fittings, of course, cost less to begin with because they use less metal. Speedline versatility, however, adds *extra* savings in installation time and labor costs that further reduce final installed costs.

*SPECIFY SPEEDLINE FITTINGS and reduce installed piping costs to a minimum*

**Piping standards have changed. It will pay you to be up-to-date with light-wall specifications that call for Speedline Fittings. Get details from your nearby Speedline Distributor today. He's listed on page 1494 of Chemical Engineering Catalog.**

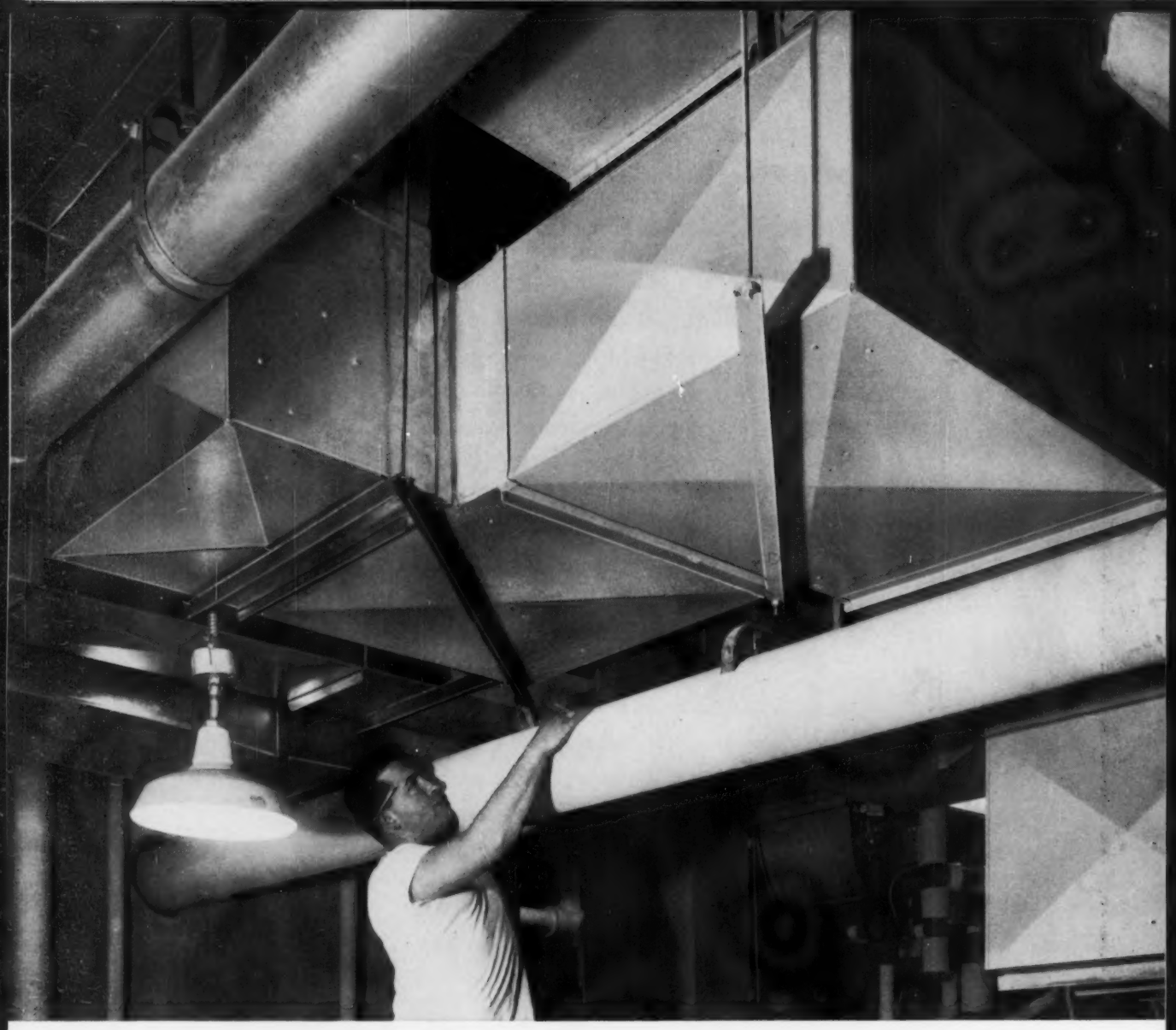
Speedline®

**CORROSION-RESISTANT FITTINGS**

STAINLESS STEEL • ALUMINUM • NICKEL
OTHER ALLOYS ON APPLICATION

300

A PRODUCT OF **HORACE T. POTTS COMPANY** • 576 E. ERIE AVENUE, PHILADELPHIA 34, PA.



# Bethcon Galvanized Sheets form up easily for ductwork that's strong and rigid

Bethcon galvanized steel sheets get a special annealing treatment that gives them a desirable blend of ductility and stiffness. That's why you can form them up easily into ductwork that is rigid and strong.

Bethlehem's continuous galvanizing process applies zinc to steel so tightly that it will not peel or flake off even when the sheet is doubled back on itself.

You can get Bethcon in a wide variety of gages, in coils or in cut lengths. A Bethlehem representative is located near you, and he will be glad to give you all the details you need.

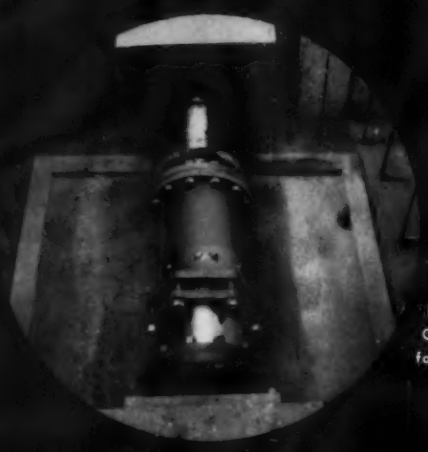
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
*Export Sales: Bethlehem Steel Export Corporation*

Galvanized Steel

*for Strength*
*... Economy*
*... Versatility*

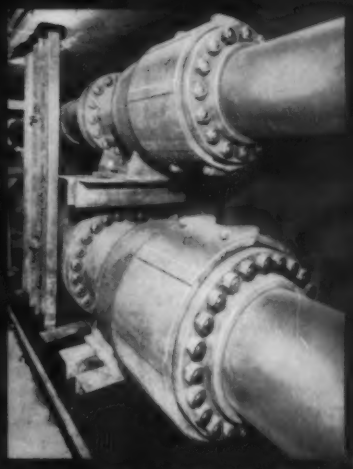
**BETHLEHEM STEEL**

BETHLEHEM STEEL



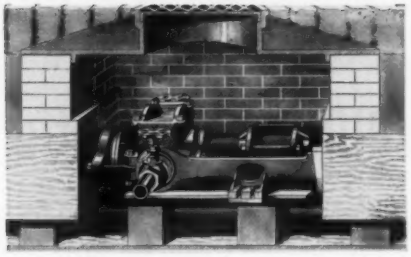
Popular type "IS" Internally Guided Expansion Joint for limited spaces.

Manhole with several Adsco Type "GIS" Externally-Internally Guided Expansion Joints.



Two Adsco 400 lb. Expansion Joints, with piston-ring feature.

# Expansion Joints ...invented here ...perfected here



Adsco invented the first expansion joint (left) more than 80 years ago and today is the world's largest manufacturer of all types of expansion joints.

The Adsco Slip-Type Expansion Joints shown here are noted for the great amount of axial motion they can absorb and for rigid guiding of slip. They have long life and are easily maintained. The Adsco Piston-Ring Expansion Joint, for instance, is the only joint which can be unpacked and repacked without shutting down line pressure.

Limit stops on all Adsco Slip-Type Expansion Joints prevent the slip from being pulled out of body. Chrome-plated slip cannot be scored by metal contact as only packing touches slip. These joints are furnished in both single and double types, in a full range of sizes, with 4″, 8″ and 12″ traverse per slip, for pressure to 400 psi and temperatures to 800° F. Special designs are available for higher pressures and temperatures.

We have been of help to thousands of piping customers since 1877. Couldn't we help you today?

ADSCO DIVISION
20 MILBURN STREET
BUFFALO 12, NEW YORK

YUBA

YUBA CONSOLIDATED INDUSTRIES, INC.

# See this good-looking DURIRON installation!

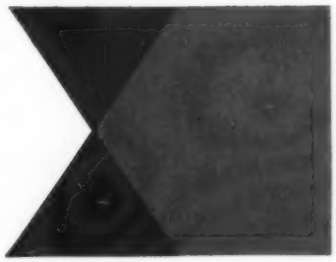
Where? It's neatly hidden behind walls and ceiling. DURIRON is so dependable, year after year, that you can safely install it out-of-sight... easy accessibility not needed. It won't corrode—even handling the toughest corrosives. 40-year-old DURIRON installations still give trouble-free service today. Try **that** on your transparent pipe!

No substitute material matches the mechanical strength of DURIRON. It's up to 15 times more resistant to breakage than "see thru" materials. And, DURIRON is heat-treated **full length** for uniform strength from one end to the other.

Install DURIRON with ordinary plumbing methods. No tricky field problems to delay work or waste material. Bury it underground without elaborate precautions, coatings or special base materials. When you plan a corrosives-handling pipe installation, remember this: DURIRON brings you **proof** of 40 years of outstanding service... performance you can depend on.

**THE DURIRON COMPANY, INC. • DAYTON 1, OHIO** DURCO

We follow here each month the practice at engineering society meetings of providing an "open for discussion" period. You are urged to take part. Just address your comments to the Editors, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2.



# "Open for Discussion"

## Don't Overlook Ground Reflection When Calculating Solar Irradiation

THE INFORMATION which is being presented in the series by Professor Hutchinson and Mr. Cotter, *Direct Reading Tables Let You Calculate Solar Irradiation Rate for Forward Inclined Walls* (April, May, and July) forms a valuable addition to the data now available on solar heat loads. One point which might be mentioned is that forward-inclined walls are more susceptible to reflective radiation from the adjacent street or sidewalk than are vertical or backward-inclined walls. When the orientation of the wall is such that it receives an appreciable amount of energy directly from the sun, there is frequently a very strong reflective component which can increase the total load as much as 50-75 percent above the values given in the Tables.

The forward slope of the wall acts to increase the angle of incidence and thereby raise the amount of energy which is reflected away from the window, but this same factor will increase the absorption of the inwardly reflected solar energy from the environment.

The writer is currently conducting work with a large solar calorimeter, and it is hoped that some numerical support of this suggestion will be forthcoming in the near future.

JOHN I. YELLOTT
*John Yellott Engineering Associates, Inc.*
*Consulting Engineers*

## Psychrometric Chart Explanation Can Be Extended to Vary Outside Air

REGARDING the article, *Simplified Case Explains the Basic Concepts of Cooling Coil Selection by Psychrometric Chart*, by George C. Stevens in the May issue, we offer the following comments —

Fortunately for the comfort air conditioning industry, including the designing engineer, the human body is capable of realizing fair comfort by adjusting to a rather wide range of dry bulb temperatures and relative humidities. If this were not so, there would be far greater complaint than there is.

The air volume that should be delivered to a space is that which will provide just adequate air motion throughout the occupied space. The condition of this delivered air should be such that when it has mixed with the air in the room and absorbed the sensible heat gain of the room, and the latent heat gain of the room, it will all be at the design conditions.

There is one other criterion — the introduced air must not be at a temperature so low that it will not readily mix with the room air and cause drafts. Thus it seems that after the maximum internal sensible and corresponding internal latent load is calculated, and the locus line is drawn, factors entirely external to the coil determine the location of Point *C* on the locus line, and the problem is one of selecting not only a coil, but a compressor balanced with the coil that results in a cooling line that also passes through Point *C*.

While such a selection may be tedious, it can be done. But, alas! Point *C* moves up and down on the locus line as the weather changes or fewer people occupy the room; and not only that but, again alas, the slope of the locus line changes.

It would seem that it is impossible to satisfactorily air condition one room, to say nothing of a whole building with many rooms, each with different load ratios, except for one more or less insignificant fact — it's being done all the time, and we're at least

*Continued on page 98*

## "Open for Discussion"

*Continued*

more comfortable with it than without it. A tolerant public is something this industry should deeply appreciate.

The graphic illustration of the problem on the psychrometric chart is very illuminating, and I'm sure the author is aware of, but overlooked, the fact that the graphic presentation of Fig. 2 in the article can easily be extended to locate points *E*, *F* and *G* on line *AH* for any percentage of outside air desired.

### How to Proceed

Let us take point *F* as an example. The linear length of line *AF* as a percent of the linear length of line *AH* is the percent of outside air necessary to mix with room air to result in a mixture with the DB and WB represented by point F.

For a graphic solution, draw a horizontal line from point *A* to point *X* on the vertical 100 F DB line. To each of the 20 divisions on this line *AX* (corresponding to the twenty 1 F DB divisions) assign a value of 5 percent. Next draw a line connecting point *X* with point *H*. Locate on line *AX* a percentage point (reading from left to right) corresponding to the desired percentage of outside air. Assume this point to be *Y* representing 30 percent, or six divisions from point *A*. Now draw a line through this point *Y* and parallel to line *HX*. Where this last line drawn intersects line *AH* can be read the WB and DB and dewpoint of a mixture of 30 percent outside air and 70 percent room return air.

Since most load calculations first result in obtaining internal latent heat in Btu per hr and internal sensible heat in Btu per hr, and the sum is the internal total heat in Btu per hr, a conversion of internal latent heat in Btu per hr to moisture gain in grains per hr can be avoided by using a psychrometric chart that provides on it the slope of the locus line in terms of internal sensible heat to internal total heat ratio.

J. A. Bishop
*Professional Mechanical Engineer*
*Dallas, Texas*

## Sees Great Promise in Natural Gas-Centrifugal Unit A-C Combination

I HAVE ENJOYED reading the article, *How to Use Natural Gas As the Prime Energy Source for Air Conditioning* in the June issue, particularly as we are at present considering the use of some such equipment.

In the section on absorption, Mr. Chamberlin has very well presented the many advantages of this equipment in which I concur. However, our experience has shown that there are still troubles to which even these units are subject. The Achilles heel that has given the most trouble on our four systems is the seals of the various circulating pumps. These have failed several times on one machine and the air allowed to enter the unit has caused considerable corrosion. We are glad to see that this weak spot has been eliminated by one manufacturer by the use of hermetically sealed pumps without seals. We consider this a great step forward that we believe will be followed by the entire industry. We have one unit of this type and are very pleased with its performance.

Since, as is pointed out in the article, the cooling tower has to be much larger than with a comparable reciprocating unit, we have found it desirable to cycle the tower fan off as the water falls to about 83 F and back on upon a rise to 87 F. Thus the fan stops just about the time the bypass valve begins to open. In cool weather, the fan may be off 50 percent of the time. On a 25 hp or larger fan motor, this represents a real saving. Also, since on these systems the water usually returns to the tower at about 103 F instead of 95, and must be cooled to about 7 F above the wet bulb, we have found that the regular 8 ft towers will not cool the water over this wide range in falling the usual 7 ft or less. We therefore specify that towers for absorption systems be not less than 12 ft high with not less than 10 ft of water fall. As the capacities of these units are principally limited by the temperature and quantity of condensing water, the installation of an adequate tower is of prime importance.

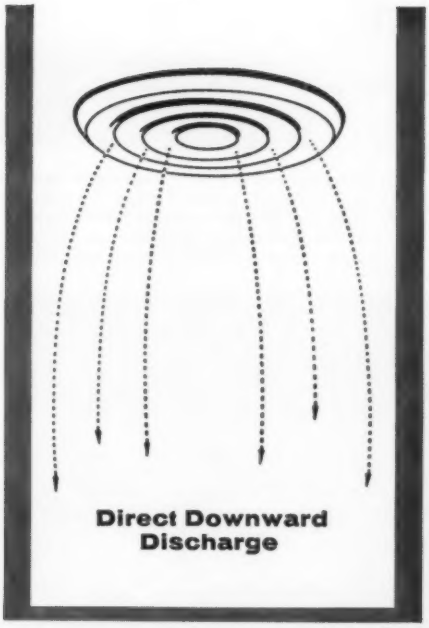
### Gas Engine Drives for Electronics Cooling

We were also much interested in the section on gas engine driven equipment by Mr. Hartwein as such equipment is being considered for standby use on a few vitally important electronic facilities where operation is dependent on cooling the year 'round and the function of the equipment is of such importance that an outage for even a few minutes cannot be tolerated.

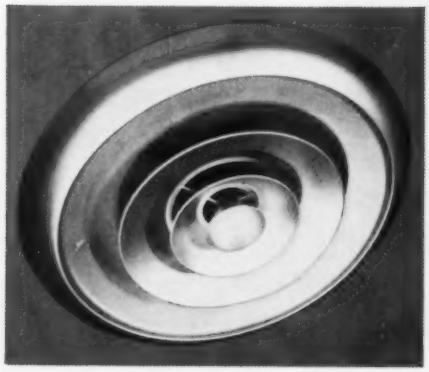
To this end, it is necessary that the standby compressor be ready to start automatically without the delay of filling a cooling tower in winter weather. Therefore it is logical to use only air cooled equipment for this purpose. We were glad to note in some literature received recently that the makers of this equipment recognize this problem and are offering air cooled water chilling units up to 110 tons.

We believe there is a big future ahead for the gas turbine driven centrifugal compressor and a companion absorption unit to recover the great amount of energy in the exhaust gases. This combination

*Continued on page* 101



Direct Downward Discharge



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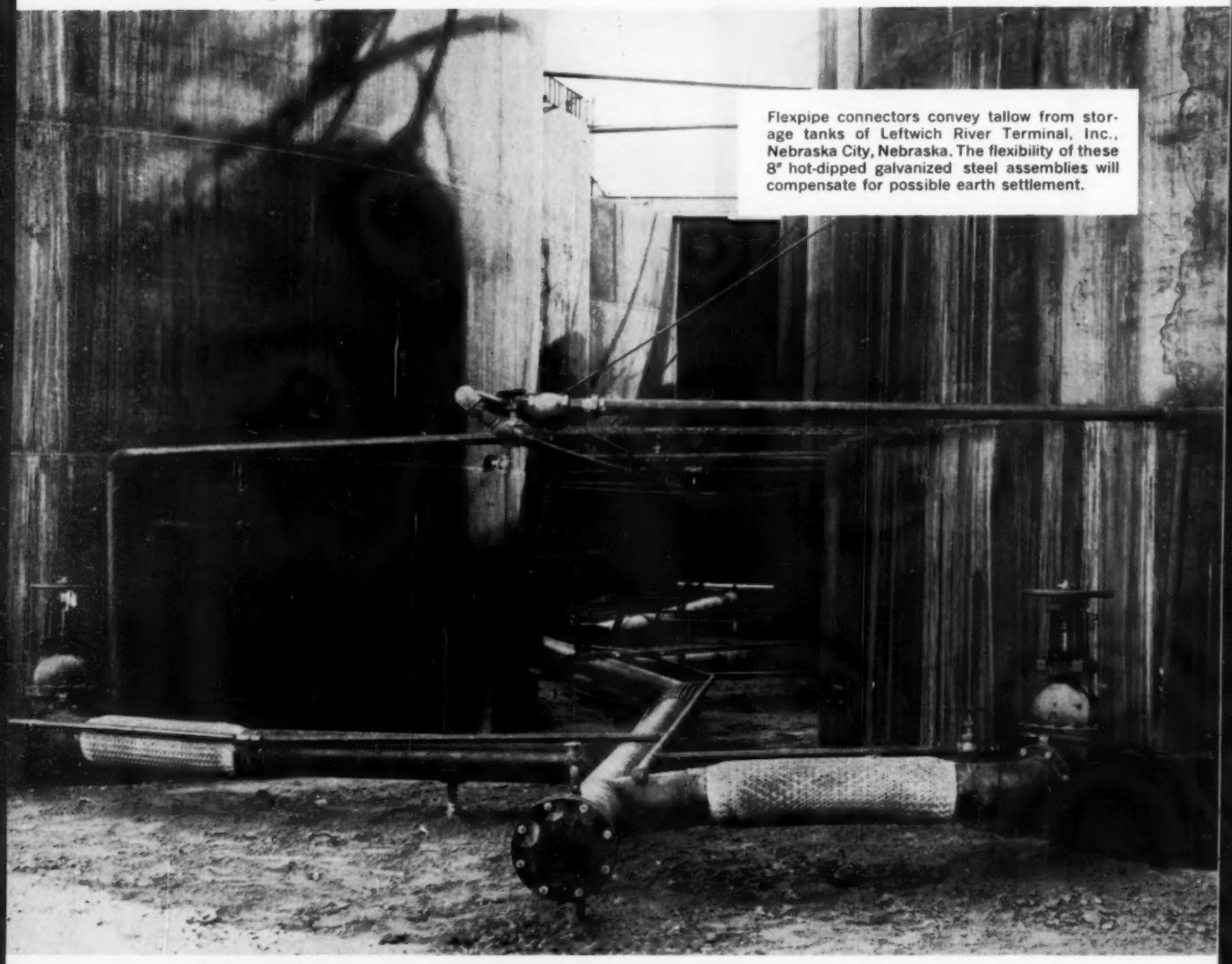

Flexpipe connectors convey tallow from storage tanks of Leftwich River Terminal, Inc., Nebraska City, Nebraska. The flexibility of these 8″ hot-dipped galvanized steel assemblies will compensate for possible earth settlement.

## Flexpipe Connectors keep tallow moving

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## "Open for Discussion"

*Continued*

should certainly be investigated by anyone designing a heavy tonnage system because of its very high efficiency. The direct fired absorption system providing both hot and cold water service for year 'round use surely has a brilliant future also and we anxiously await the announcement of more manufacturers in this class of equipment and the production of larger units than the 25 ton system now available.

In Mr. Hartwein's comments he uses the term "Sones" in discussing sound intensity. I find this to be an unfamiliar term to all engineers I have contacted. We feel an article on the relationship of "Sones-to-Decibles" would be appreciated by the majority of readers.

LESTER S. SAVAGE
*Mechanical Engineer*
*Tinker Air Force Base*
*U. S. Air Force*

## Suggests Corollary to Simplified Sound Output Rating Method

WE HAVE REVIEWED the article in the February issue, *Proposed: A Simplified, Comparable Method For Rating the Sound Output of Air Distribution Equipment,* by J. W. Spradling. Several of us at Bolt, Beranek and Newman, Inc. have reviewed this and all feel that a proposal of the type being made by Mr. Spradling is a significant contribution to the heating, air conditioning, and ventilating field. We would, however, like to make two criticisms and one corollary proposal.

We feel sure, from the nature of Mr. Spradling's suggestion that he is discussing terminal devices such as diffusers, grilles, and induction units which actually generate noise within the occupancy spaces of buildings. We feel that except to the manufacturers of diffusers, the term "air distribution equipment" might imply fans and ducts as well. Obviously the proposed PWL-NC Index cannot apply to noise-producing elements outside of the listening room because the transmission path between such sources and the listening room will modify the frequency spectrum. We therefore suggest that this limitation of the proposal might have been explicitly stated.

Mr. Spradling frequently uses the term "room attenuation." We feel strongly that the term "relative sound pressure level" should be used for consistency with prior practice. The latter term has been in use in the acoustical literature for a considerable number of years and is familiar to most of the people who will be using the proposed Index. After the first mention of "relative sound pressure level" it would have been well to refer to Fig. 20 in Chapter 25 of the HVAC 1961 Guide, in our opinion.

Our suggestion is based on research in a specific aspect of diffuser noise. We have found that the solutions to most problems of transmission of sounds such as speech, music, and intermittent noise are dependent on the ambient sound level observable in the complainant's room. Normally, in an air conditioned or ventilated building, this ambient, at least for the frequency range above about 300/600 cps, is established by the noise of terminal air devices.

Mr. Spradling's proposal offers a one-number index with a frequency weighting which is related quantitatively to the annoyance that will be produced in completed structures. The proposal we would like to make, in addition to relating the annoyance, can be used to estimate precisely the "masking effect" of the noise. From our proposed scheme it is also possible to retrieve from the single number rating at any later date the actual sound pressure level in the five octave bands from 150 cps to 4800 cps. The scheme is effected as follows:

1) Determine the octave band sound power levels (PWL) of the terminal device in question as a function of a given operating condition (cfm and pressure drop as well as temperature if this is found to be a significant parameter) and plot on octave band graph paper. The graph paper should be of a predetermined type, such as paper in which the octave bands are spaced 1 in. apart horizontally, and 10 db equals 1 in. vertically.

### Use Matching Transparency

2) On top of this graph place a transparency having four spectra plotted on a grid similar to the one described above. The transparency is aligned with the frequency scale and then adjusted vertically until a "best fit" with one of the four spectra is obtained. An arrow at the left-hand margin of the transparency points to a number on the vertical scale of the power level graph. This number will turn out in each case (as a result of the placement of the four spectra) to almost precisely equal the NC-power level index number, as defined by Mr. Spradling.

The four spectra shown on the transparency (Fig. 1) are each designated by a letter. The letter *H* indicates a noise spectrum having predominantly high frequency energy; *M* a spectrum of mid frequency energy; *L*, having predominantly low frequency energy, and finally, the *N* spectrum is exactly parallel to the NC-30 spectrum.

The final rating number given to a diffuser by this method for example, might be *H*-50. This informs the user of several things. Let's assume, for example, that the relative sound pressure level equals −20, in which case, the sound pressure level rating of this

*Continued on page* 102

## "Open for Discussion"

*Continued*

particular diffuser would be *H*-30. The user would therefore know that the room would have a sound pressure level which is equal to or lower than NC-30 in every octave band as a result of the operation of the diffuser. It would also be possible for the user to determine that the octave band sound pressure levels generated by the diffuser are approximately (usually ± 2 db) equal to the following:

| Frequency | Sound pressure level, db |
|---|---|
| 150-300 | 31 |
| 300-600 | 31 |
| 600-1200 | 32 |
| 1200-2400 | 30 |
| 2400-4800 | 28 |

It can be noted that the spectrum of this noise matches the NC spectrum shape only in the upper three bands given in the table, corresponding to the *H* designation.

### How Data Can Be Used

Such information would be useful if you know the octave band sound pressure level of an intruding noise in the space because from the octave band diffuser data it is possible to determine the signal to noise ratio that will result.

This type of rating number is currently being incorporated in the "Speech Privacy Analyzer" which we have developed under the sponsorship of Owens-Corning Fiberglas Corp. which is to be published this year. Thus, the adoption of this rating scheme by the manufacturers of air distribution equipment would make it applicable to a device useful to architects and mechanical engineers which we believe is going to gain wide usage.

We submit this for your consideration.

W. R. Farrell
*Bolt, Beranek and Newman, Inc.*
*Consultants in Acoustics*

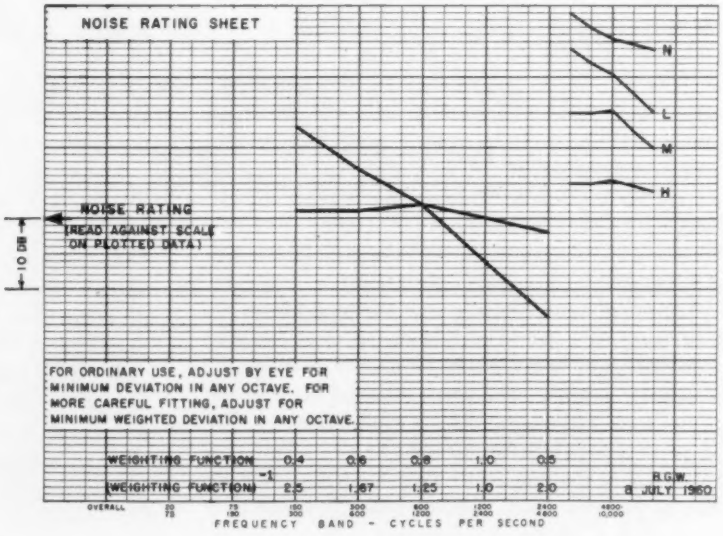
The Author's Reply — W. R. Farrell's support of the proposed method is appreciated. His corollary proposal offers an important improvement, for its inclusion would greatly increase the information which can be conveyed in the single number rating. We will recommend it for consideration when the newly formed Air Distribution Institute commences work on its standard sound rating code. This institute is composed of manufacturers of commercial diffusers, grilles and terminal control units.

The term "air distribution equipment" is used in the article in accord with the jargon of the heating, ventilating, and air-conditioning engineers and their GUIDE.

### Terminology Used as Practical Measure

Because the article was written for the engineer who has the day-by-day responsibility of designing air conditioning systems, rather than for the acoustician, I took the liberty of using the positive term "room attentuation" for the expression 10 log $(Q/4\pi r^2 + 4/R) + 0.5$ db, rather than the less descriptive "relative sound pressure level" with its attendant negative values.

Joseph W. Spradling
*Product Engineer*
*Carnes Corp.*




**1 TRANSPARENCY** described by Mr. Farrell, for use in rating masking effect of noise and in determining sound pressure level in five octave bands from 150 to 4800 cps

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# question of the month

## "How Can We Get Smooth Operation When Heating with High Pressure Process Steam?"

***This question was asked previously in Heating, Piping & Air Conditioning, and is repeated here, along with two answers that have been received. Other solutions or comments for publication are invited.***

*"In designing a heating system to operate in conjunction with high pressure process steam, certain questions have arisen in our office.*

*"The boiler is to operate at 150 psig, and condensate is to be returned through a vented receiver and pumped back to the boiler. None of the steam should be contaminated.*

*"In designing the heating system for the building, which will include 11 unit heaters averaging 300,000 Btu per hr output, questions concerning the selection of the traps and the disposition of the flash steam likely to be encountered need clarification. We are not sure about the trap selection — whether to use a bucket trap or a float and thermostatic trap.*

*"Would the intermittent discharge of a bucket trap cause more flash steam to form with resultant noises in the return line?*

*"Would any flash steam brought back to the vented receiver be of such a quantity as to be objectionable?*

*"Since the ceiling height is great and there is no danger of anyone burning himself on the return main, we have considered the possibility of leaving off the return main insulation to insure condensation of any flash steam by the time it gets all the way back to the receiver.*

*"The equivalent length to the most distant unit heater is approximately 500 ft. Pipe sizes are based on a pressure drop of 5 psi in the supply main. Should any precaution be taken for noise due to excessive steam velocity?*

*"We want to be sure that any banging in the return line due to the flash steam is prevented. The return piping has been sized for a pressure drop of 0.5 psi. We have considered the possibility of installing a 3 ft section of fin pipe after every trap at each unit heater to assist in condensing any flash gas. Do others think this is necessary? Are there any precautions which should be observed in particular?"—L.L.L.*

### Suggests Separate Systems With Cross-Connect for Emergencies

I WOULD LIKE to give some of my thoughts on this subject. However, most of my comments will be quite general in nature since there are factors other than those given that could complicate or simplify this problem.

One comment I would like to make, though not specific, concerns the course we followed when we built our new plant a couple of years ago. We require high pressure steam for testing as well as low pressure for low pressure testing and space heating. After due consideration we decided on two separate steam systems; one high pressure for processing and one low pressure boiler for low pressure testing and space heating. These systems can be cross connected so that in the summer or during an emergency we can use the high pressure boiler for heating and testing. Perhaps our situation differs for many reasons, from this problem, but two separate systems best suited our requirements.

In answer to the specific questions, we offer:

a) The intermittent discharge of the bucket trap could be noisy. How noisy would depend on several factors. The bucket trap action, because of its nature, is definitely cyclic and blows or puffs on the discharge cycle. The discharge action is almost a snap action as compared to the action of a float and thermostatic trap which is quite smooth.

b) Regarding the possibility of steam being

*Continued on page* 106

## question of the month

*Continued*

brought back to the condensate pump in objectionable quantities, I would say "yes"; it would be objectionable. Just how objectionable is problematical because it would depend on how much cooling or condensing effect would result in the cooling legs or in the return lines. One suggestion I might make along these lines is to run the return steam and condensate through a shell and tube heat exchanger to cool it down.

Regarding velocity noises, when sizing the supply or return mains, I would suggest a compromise between cost, efficiency, and noise level. The most efficient sizing of the piping would result in a higher noise level.

Regarding reducing the temperature of the steam on the discharge side of the unit heaters, finned tube would help to prevent steam in the return line. However, how much and what size finned tube would be required would depend on factors such as ambient temperatures, finned tube rating, etc.

Because a great deal of stress has been placed on "noise", it would be my suggestion that a split system be considered for this job. For one thing, has it been determined whether or not a premium would have to be paid for the unit heaters and all the other equipment necessary to use 150 psi steam for space heating?

Just what kind of a split system would be best for this job is another chapter.

C. H. Herrick
*Assistant Sales Manager*
*Sterling, Inc.*

### Tells What to Expect from System, Suggests Ways to Handle Flash Steam

Although the unit heaters take steam from a 150 psi process steam main, we will assume that none of the process steam is used in the area to be heated. Thus, the vented receiver to which unit heater traps discharge will not handle condensate from process units. Nor will flash from process condensate be available for supplying low pressure steam to the unit heaters.

Presumably, the process steam main extends through the area to be heated with multiple take-offs from the top of the supply main for supplying steam to the unit heaters. The idea of the single take-off with a pressure reducing station and separate steam supply for the unit heaters could have been considered and rejected on account of cost.

In general, unit heater manufacturers recommend bucket traps for medium and high pressure service. As compared with conventional float and thermostatic traps, the bucket type have several advantages such as:

1) Open float cannot collapse.

2) Mechanical elements have longer life and may be more dependable than thermostatic elements.

3) Bucket traps are available with all stainless steel working parts.

4) Bucket traps will vent $CO_2$ at steam temperature. No cooling leg is required during which $CO_2$ can go into solution and form corrosive carbonic acid.

The same percentage of flash steam will be formed if the condensate temperature from float and thermostatic and from bucket traps is the same. Puffs of flash steam from a bucket trap would be followed by periods of no flash steam. With 11 unit heaters operating, condensate discharge and flash formation should be uniform regardless of the type of trap used. Even so, puffs of flash should not produce noise in a properly sized and pitched condensate header. Noise is a problem when a trap discharges to a line filled with relatively cool condensate. This situation would not occur in a well designed system.

The 11 unit heaters would condense 3850 lb of steam per hr when operating at full capacity. Theoretically, 158.5 Btu will be released from each lb of condensate when discharged from 150 psig to the atmosphere.

Thus there would be 3850 x 158.5 or 61,000 Btu to be dissipated by radiation loss from return lines. Assuming an average return line temperature of 220 F and an ambient temperature of 70 F, each sq ft of return line service would radiate 150 x 3 or 450 Btu. The 61,000 Btu to be dissipated divided by 450 gives a required radiating surface of 1356 sq ft, which is equivalent to 2712 lineal ft of 1-½ in. pipe.

Since it hardly seems likely that the return piping from the 11 unit heaters would provide 1356 sq ft of surface, it follows that at peak loads flash steam will escape from the receiver unless provisions are made to condense it.

If hot water is used in the area heated, returns from the unit heaters or the flash from the unit heaters could be piped through a heat exchanger to kill the flash steam and give a valuable by-product — hot water.

Live steam makeup could well be needed to supply all the hot water required.

Another solution would be to install a flash tank ahead of the condensate receiver. The tank would be drained by a trap of suitable capacity discharging to the receiver. The flash steam could be piped to one or two unit heaters which in turn would discharge to the condensate receiver.

T. H. Rea
*Armstrong Machine Works*

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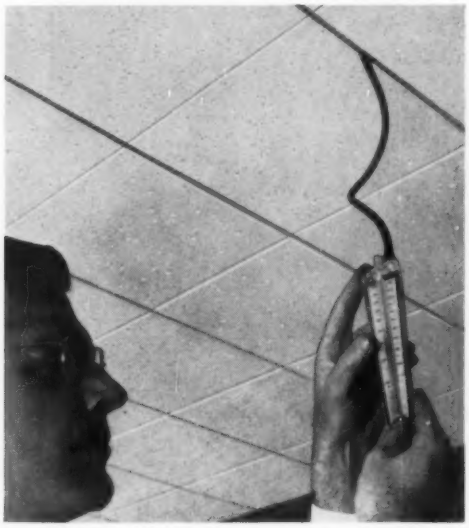

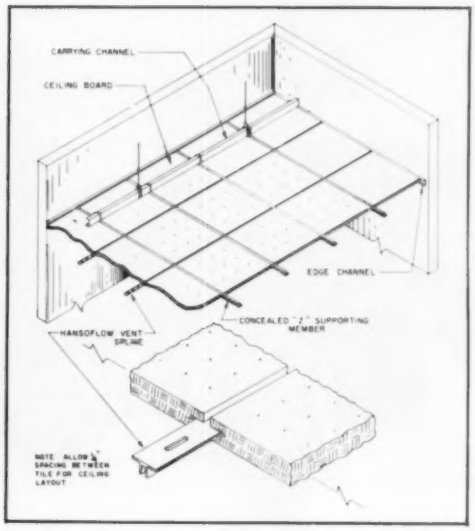


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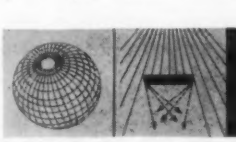

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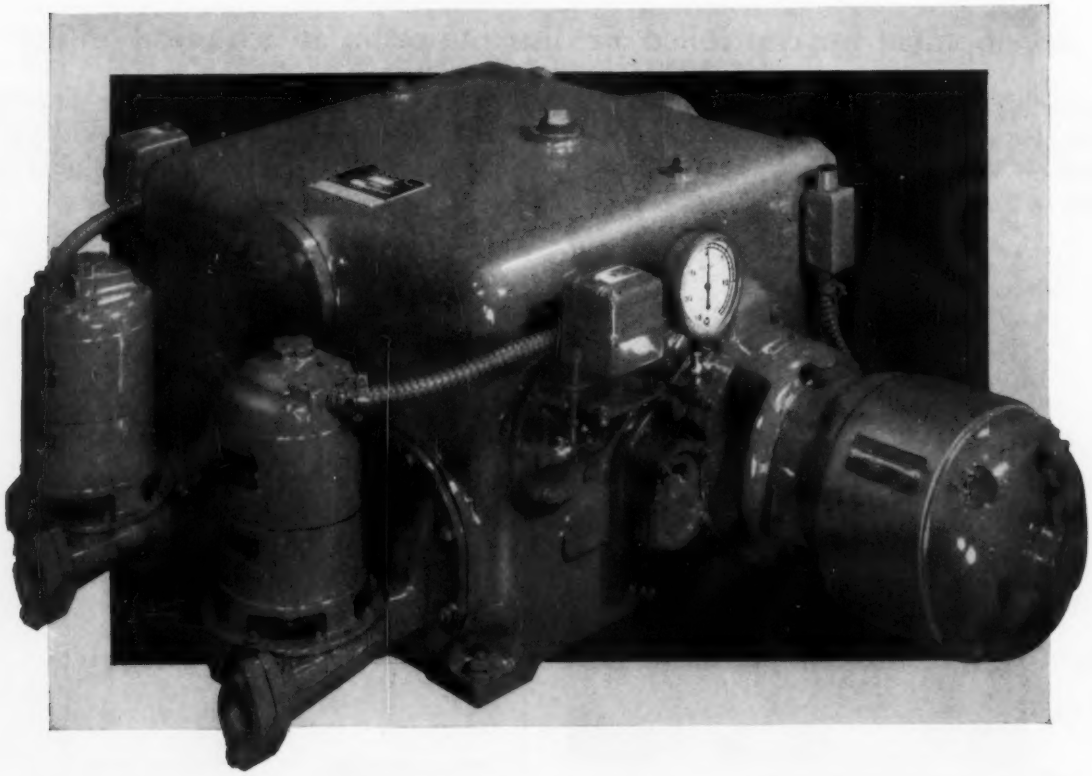

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These pumps possess many other features which permit a more efficient utilization of fuel and minimum use of electric power. Low, low returns reduce installation costs and usually eliminate putting the pump in a pit. Simplicity and efficient operation reduce supervision and maintenance costs. Information regarding this new heating pump development is available immediately upon request.

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Simplified semi-graphical method based on the "elastic center" concept allows the piping designer to

# Calculate Expansion Stress in Pipe Bends For Single-Plane Structures

By C. A. LEE
Mechanical Engineer
United States Steel Corp.

THIS ARTICLE explains a simplified means for calculating expansion stress in piping for steam or hot fluids. The method is based upon the "elastic center," and has the same limitations as are found in the Spielvogel solution.

In other words, the method would have little application to the large modern central station with high superheat, multiple fixed points, and close-coupling. For such cases, a matrix-type computer solution is indicated. The method does apply however, to many cases which seemed difficult 15 years ago.

## Why Is Method Needed?

There are many mechanical engineers who have never heard of matrix-type solutions; who will be surprised to learn of the limited value of handbook and databook solutions; and who, to tell the truth, handle problems which do not require a solution which is exact under 1961 standards. This article is addressed to them.

The "elastic center" method is an extension of the two theorems of area-moments. Texts on advanced strength of materials present these theorems, and it is assumed that a partial outline will suffice here.

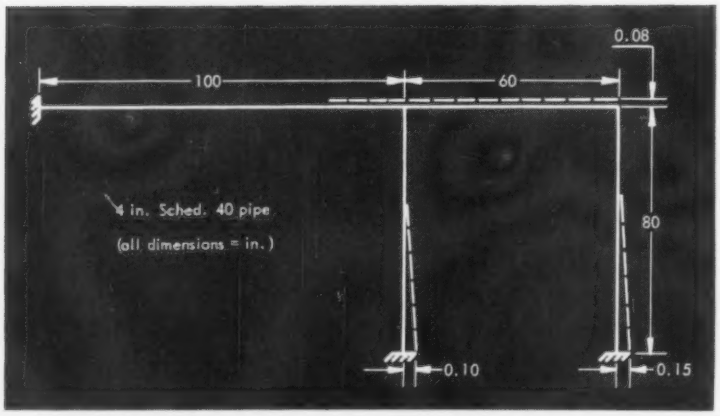
In accordance with the first theorem, if there is no change in slope at the anchor points, the net area of the $M/EI$ diagram is zero. Or if $I$ be constant, then the net area of the moment diagram is zero. The total area is of course made up of components which change sign in crossing the neutral axis.

This, the first theorem, is the basis of the "grapho-analytic" solution given in Sabin Crocker's *Piping Handbook*.

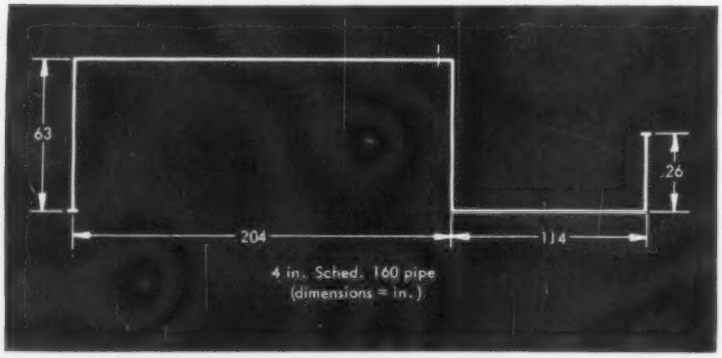
## Second Theorem

In accordance with the second theorem, if there is no deflection at the anchor points, the static moment of the $M/EI$ diagram is zero.

It is convenient in our case to




**1** THREE-ANCHOR point problem illustrated here, which has *not* a single neutral axis, is excluded from solution method offered in text




**2** SIMPLE STRUCTURE, considered as having single neutral axis, lends itself to simplified pipe stress solution explained in text

free one end, figuratively speaking, and to determine the combination of thrust and moment required to correct the expansion. The reversal is treated as a deflection. In this case the static moment of the $M/EI$ diagram is numerically equal to the deflection.

The problem is simplified if we base our calculations on the elastic center. We mention without proof that if the $X$ and $Y$ components of the thrust are considered as applied at that point, those forces multiplied by the $X$ and $Y$ coordinates of the ends yield the numerical value of fixed-end moments.

A misapplication of the second theorem was the basis for the once-popular "Mitchell Method," which can be dangerously inaccurate but which still appears in at least one current databook.

Pioneer work on the graphoanalytic method was done by Paul Todd at the Detroit Edison Co., and quite a lot of important work was handled successfully using that method.

Times have changed and brought a need for increased accuracy. The weakness in the original method is that no attention is paid to the second area moment theorem. The hazard using the Mitchell Method lies in the fact that it is based in an untenable neutral axis location.

## How New Means Is Limited

The only limitation on the proposed semi-graphical method (and on the Spielvogel Method) is that the part of the structure analyzed should have a single neutral axis. For instance, the three-anchor point problem represented by Fig. 1 is not covered by our solution. The analysis indicated by Fig. 2, however, is easily handled.[1] The same answer is obtained in the latter instance, using the semi-graphical method as is obtained by the Spielvogel method. The new approach is perhaps best justified on the basis that "one picture is better than a thousand words."

## Virtual Lengths

Here we should digress briefly to discuss "virtual lengths." In Fig. 3(1), the area of the moment diagram is intensified at the $A$ end of the arc, and the result is shown in Fig. 3(2). The moment at any point is Pr $\sin\theta$ and is distributed over arc r$d\theta$. If $A_M$ is the area of the area-moment diagram, then

$$dA_M = Pr \sin\theta \times rd\theta$$
$$Pr^2 \sin\theta d\theta$$
$$dA_M = Pr^2 \int_{0^\circ}^{90^\circ} \sin\theta d\theta = Pr^2$$

In other words: $P$ times the area of the square r $\times$ r.

This justifies the use of a "square corner" solution. However, there is more to it than just that. There is extra flexibility in a standard ell or curve. On the other hand, there is also an intensification of stress. Thus, there is on the one hand a slightly reduced thrust for the same expansion; and on the other hand an elbow at a point of high moment should be checked for stress. The method to accomplish this has been discussed at length in books sure to be in the piping engineer's library.

In the case shown in Fig. 2, elbows are a small part of the problem and may be neglected. Now let us analyze this structure.

The "elastic center" is the center of gravity ($cg$) of a fictitious area of the same shape as the given structure, made up of components whose width equals $1/EI$. In this case, $I$ (and $E$) are

[1]The problem in Fig. 1 may be easily solved by the Slope Deflection equation $M_{AB}/2EK \quad (2\theta_A + \theta_B - 3\psi_R)$

constant and the elastic center is located at the center of gravity of the structure.

The location of *cg* is a "shape factor" determined by conventional methods. Other shape factors are $I_y$, the moment of inertia about the *X*-axis; and $I_x$, the moment of inertia about the *Y*-axis.

The final shape factor is the product of intertia $I_{xy}$, about the two axes. The inertia shape factors are figured about any conventiant axis and transferred to the center of gravity.

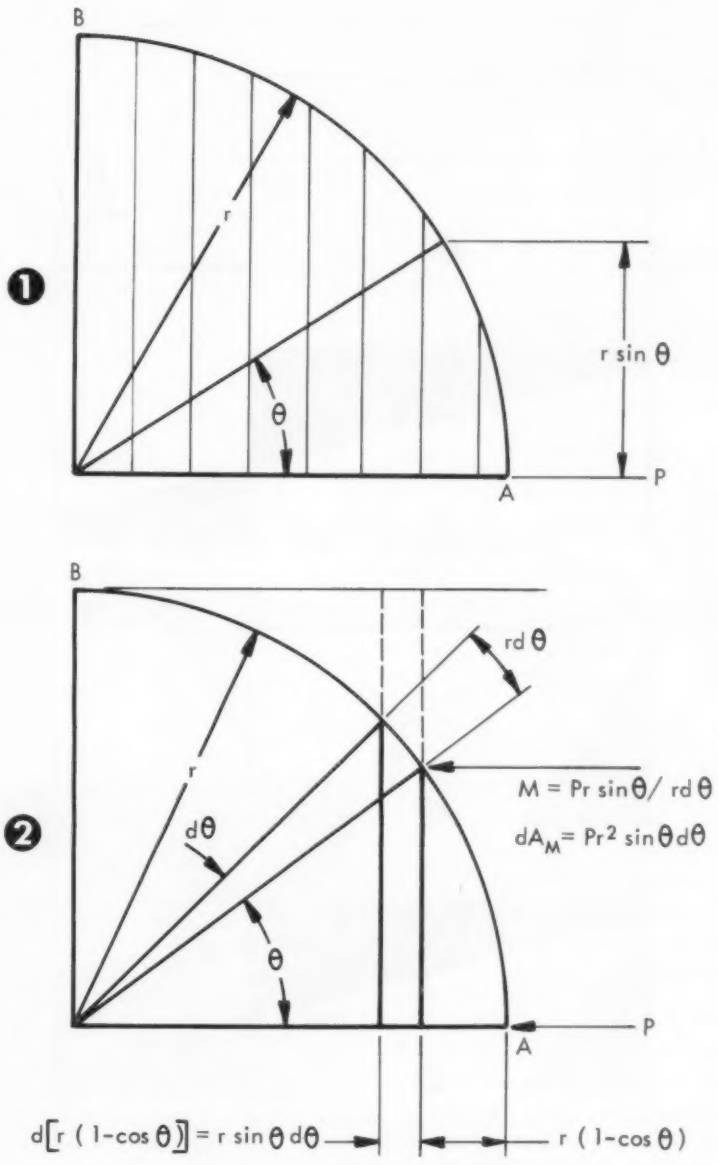
### Example Shows Method

The following example will serve to explain the use of this method in the single-neutral-axis problem. Shape factors for Fig. 2 are calculated using the conventional method.

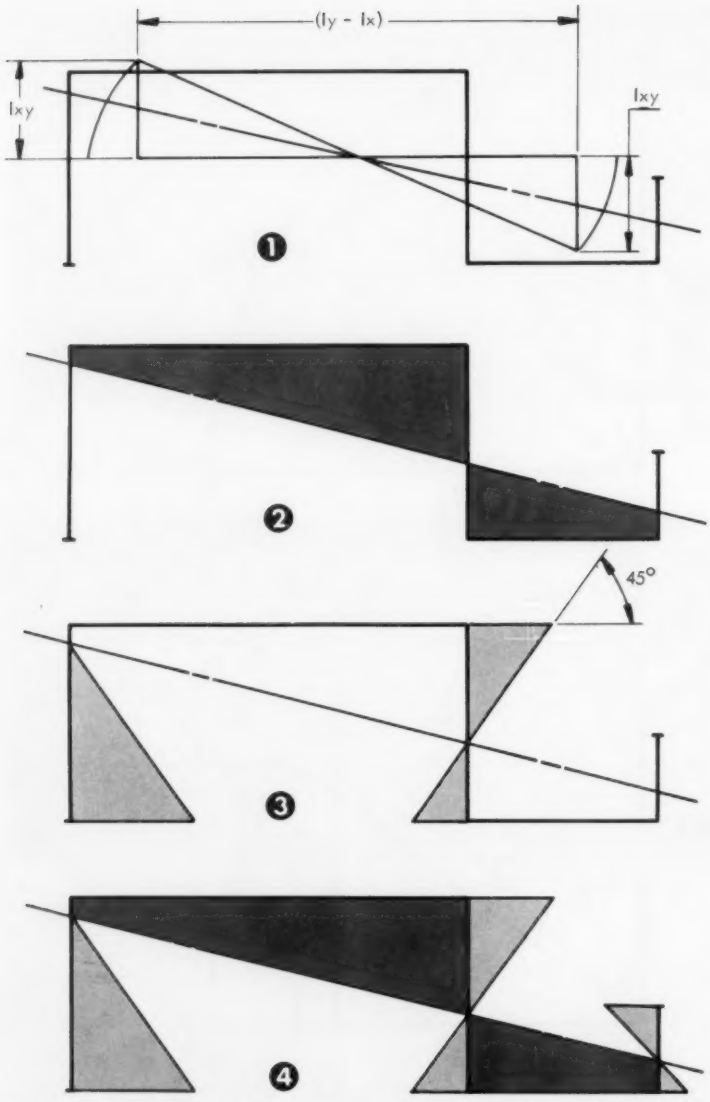
Fig. 4(1) is a construction of the problem shown in Fig. 2, based on Mohr's Circle of Inertia for locating the neutral axis. (It very definitely is not in agreement with that assumed in the Mitchell Method.)

The pipe structure is drawn exactly to scale; say 1 in. = 50 in., and a horizontal line is drawn through the *cg*. On the horizontal line, the difference between $I_x$ and $I_y$ is laid off, half on either side of the *cg* as shown. A reasonably large scale is used, and to the same scale, vertical lines are erected equal to $I_{xy}$. $I_{xy}$ may be positive or negative. If negative, as in this case, $I_{xy}$ extends downward at the right, and upward at the left.

On either side of the *cg* two sides of a triangle have now been constructed. The third side is a radius (of Mohr's Circle) for an arc which is bisected to get points on the neutral axis. The neutral axis crosses the pipe line at points of zero moment. Thrust along the neutral axis is the same at all points, and moment at any point is in direct proportion to the distance. For instance, moment at a point equals (inclined) forces along the neutral axis times the




**3** VIRTUAL LENGTH notion is illustrated by two drawings above. The area of the moment diagram is intensified at the *A* end of the arc in (1), with the result shown in (2). Moment at any point of the structure equals *P* times the radius times the sin of the arc $\theta$, distributed over the arc $rd\theta$. "Shaded area" refers to lower vertical extension from arc $rd\theta$




**4** MOMENT DISTRIBUTION for structure of Fig. 2 is developed graphically as shown here, with 1) neutral axis construction, 2) horizontal element moments, 3) vertical element moments, and 4) complete moment diagram

(inclined) distance to the neutral axis.

It becomes obvious that moment is also exactly equal to horizontal component of the thrust times the vertical distance to the point. This is the basis for the simplification.

Since the structure was drawn to the scale 1 in. = 50 in., the moment diagram is drawn to the scale 1 in. = 50 in.-lb. A thrust along the neutral axis such that the horizontal component will be 1 lb can be assumed.

So far as horizontal elements are concerned, space bounded by the neutral axis comprises the moment diagram, as shown by the shaded area of Fig. 4(2). For the vertical elements, the moment diagram is drawn with a 45 degree triangle as shown in Fig. 4(3). The complete moment diagram, combining the horizontal and vertical components, appears as Fig. 4(4). This is an exact picture of moment distribution, and the problem is only to find the scale factor which corresponds to actual thrust.

The moment diagram consists of trapezoids and 45 degree right triangles. Areas of the trapezoids are figured, and their *cg's* located along the pipe. The vertical distance from the trapezoid *cg* to the neutral axis times the area of the moment diagram equals the area moment.

The triangles can be considered collectively. The side of each is cubed, and the sum of the cubes divided by three. The result is added to the moment for the trapezoidal areas. All moments of moment-areas are positive.

For a structure in which the neutral axis crosses a horizontal element, the moment of moment-area equals one-third the base times the square of the height.

Let $X$ be the horizontal component of the actual thrust.

If $M_A$ is the total summation of area-moments, and $\triangle_x$ the horizontal component of the expansion, then

$$M_A X = \Delta_x EI$$

Inserting the proper values,

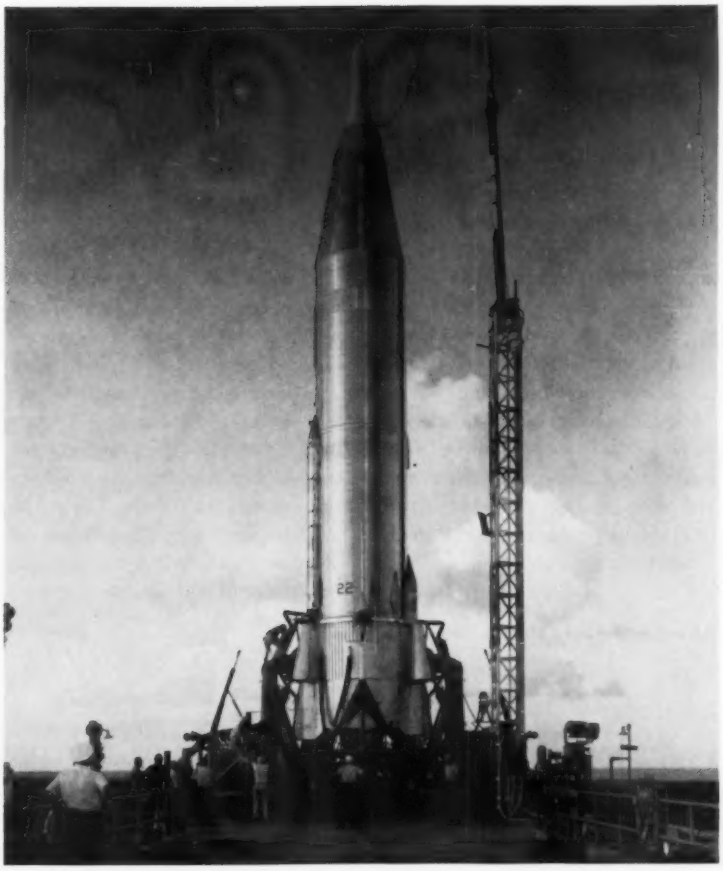
$$\begin{aligned} 233{,}500X &= EI(0.588 \text{ in.}) \\ X &= (3.61)(10^8)(0.588 \text{ in.})/ \\ &\quad 233{,}500 \\ &= 910 \text{ lb} \end{aligned}$$

## Summary

This is a theoretically exact method for drawing the moment diagram for a fairly complicated single-plane problem. The application is simpler than the theoretical principles might suggest. The method is recommended especially for non-symmetrical problems. When the structure is symmetrical, published charts based upon the older grapho-analytic method are adequate.

Extension of this method to the multiplane problem is not difficult for simple cases. However, in such problems the neutral axis is located in space, moment arms become a problem in projective geometry, and a more sophisticated method of analysis may be desirable. For examples of the type shown in Fig. 2 the semi-graphical method is very worthwhile. ⧺

# Portable Air Conditioner Cools Missile "Brains" During Countdown



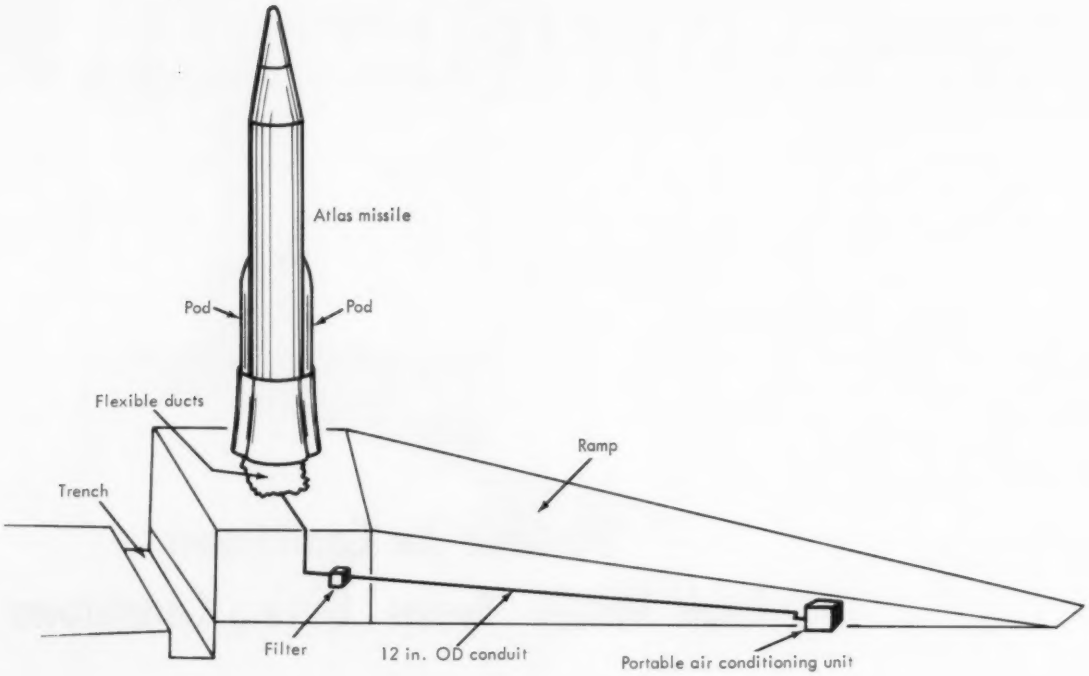
By LESTER S. RIES
Consulting Engineer

WHEN the countdown is completed on an Atlas missile, and the "fire" button pushed, things start to happen if the electronic brains of the missile are operational.

To direct this huge bulk on the start of its journey into space, instrumentation pods containing the sensing and control devices are mounted 180 degrees apart on the outside lower portion of the missile body.

### Pods Must Be Cooled

The pod interiors, with their sensitive cargoes, must be kept relatively cool to prevent ruinous accumulation of heat during the countdown stage. The Fred F. Antelline organization had the assignment of conditioning the brain pods to insure proper functioning from the time the scientists and technicians have completed their work until the missile is launched.




Each of the two pods for a missile are 12 ft long, 3 ft wide, and about 15 in. deep. Successful functioning of the control devices on the launch pad demands dust free air delivered to the pods at 40 F and 45 percent relative humidity.

### Build Special A-C Unit

A portable self contained air conditioning unit furnishes this service. Constructed of 16 gage steel, the unit measures 12 ft by 8 ft by 8 ft. The air cooling compartment is designed with a glass fiber-insulated double wall to withstand 36 in. WG pressure.

### Single Housing Does Job

A 75 ton reciprocating compressor, air cooled condenser coils, evaporator coils, supply fan and filter, electric strip heaters and dual conditioning equipment are all housed in the single casing.

An additional filter is located close to the air delivery point at the missile. The dual conditioning design with alternate defrosting was required to forestall a coil icing condition in order to insure continuous delivery of uniformly conditioned air to the pods.

### How It Works

The 25 hp, 24 in. diameter supply fan pulls 2400 cfm of air via 2 in. pre-filters through a 12 row DX precooling coil which lowers the air temperature from 95 F ambient temperature to 55 F.

Beyond the precooling coils, air is passed over a constantly energized electric strip heater to raise the temperature to about 65 F. Should the temperature of the air leaving the supply blower drop below 65 F, the precooling coil and strip heater are shut down temporarily until the 65 F temperature is re-established.

### Alternate Flow Paths

The air then passes through either one of the dual conditioning units. Each conditioner contains a 12 row DX cooling coil followed by an electric strip re-heater. Leaving air temperature from the cooling coil is 20 F. The temperature is raised to 35 F as it passes over the heater.

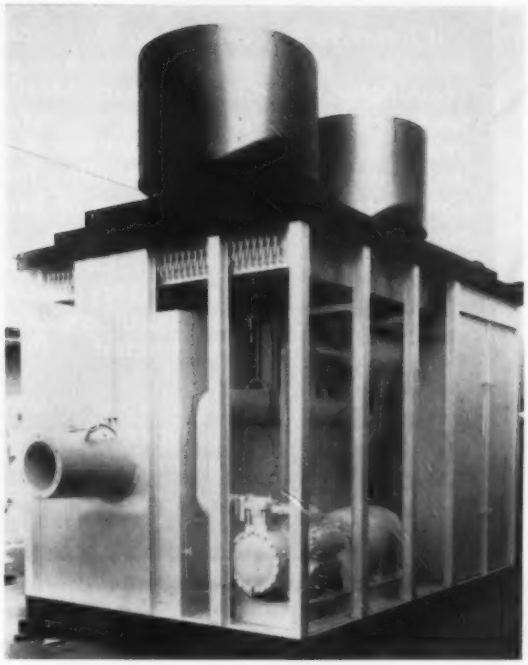
A complete operating cycle for the whole unit takes 40 minutes. An operating damper deflects the supply fan discharge to one of the two main cooling coils for exactly 20 minutes, then reverses the cycle.

### Defrost Cycle

During the period when each half of the unit is idle, its strip heater is on full for six to seven minutes to defrost the coil. During the final three minutes of the idle cycle, the cooling coil is again brought on the line for pre-cooling, so that it is fully cooled when the switch-over occurs. The cycles are always exactly 20 minutes out of phase with each other, so that the recirculation fan can operate continuously.

### Condenser Forms Roof

A 75 hp motor drives the Refrigerant 22 compressor which operates with a 0 F suction temperature serving the two conditioning coils and a back pressure



MISSILE COUNTDOWN arrangement, diagrammed at left, includes portable cooling unit located about 200 ft from launch pad. 12 in. duct conveys cooling air to flexible connectors, thence to missile "brain" pods. At right — this is compact unit which helps complex control devices function properly. Air cooled condenser, with fans above, forms roof of unit. Start of 12 in. duct, reciprocating compressor are also visible

regulator that is set to hold the 35 F suction temperature on the precooling coil. The unit's condenser serves as a roof for the housing, on which are mounted two vertical updraft condenser fans.

### Move Unit to Site

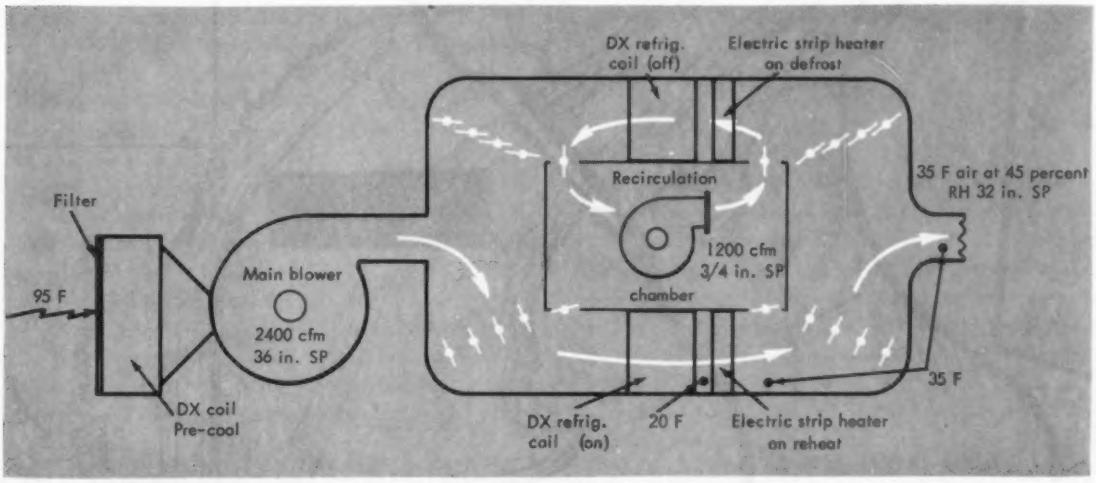
The entire air conditioning unit is located on the launching site about 150 to 200 ft from the missile. A high pressure (36 in. WG) double wall duct, of 12 in. outside diameter, carries the air to the base of the missile via a 12 in. deep high efficiency filter.

Both inner and outer shells of the transfer duct are constructed of 18 gage galvanized steel, and the two are separated by a 2 in. glass fiber insulating layer.

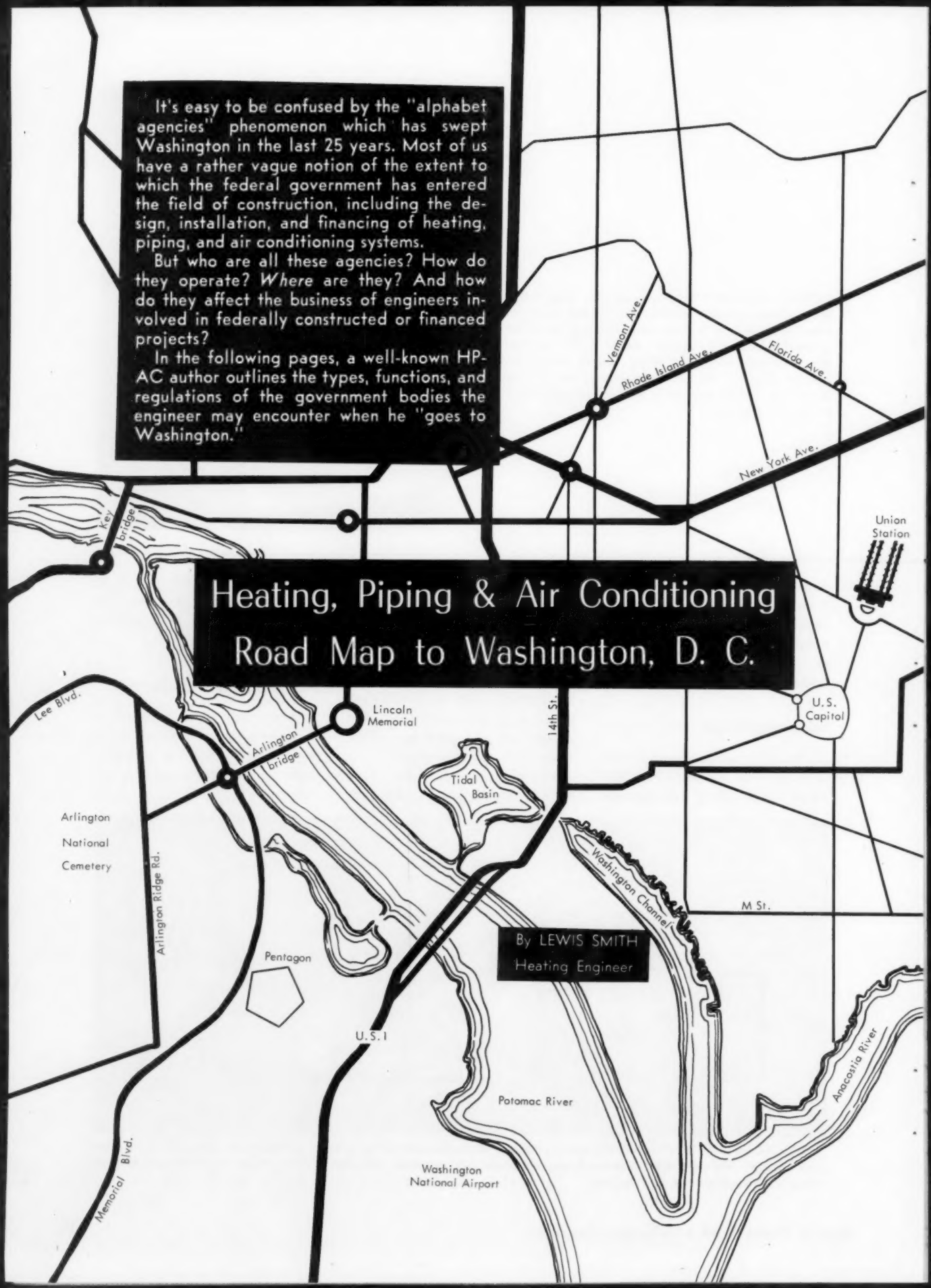
Flexible connectors lead from the duct to the base of each pod. Air is delivered to the pods at 40 F, 45 percent RH, and with dust particles 5 microns and larger in size removed.

### Blast-Off Breaks Connection

Conditioned air is supplied to the pods continuously during countdown. As the missile is launched, cooling connections are broken automatically. ⧺




CYCLICAL OPERATION, to insure continuous supply of conditioned air to pods, is accomplished as shown above. Unit would operate like this for 20 minutes, during which one coil would be defrosted, then dampers would reverse and defrosted coil would assume cooling load




# Heating, Piping & Air Conditioning Road Map to Washington, D. C.

By LEWIS SMITH
Heating Engineer

It's easy to be confused by the "alphabet agencies" phenomenon which has swept Washington in the last 25 years. Most of us have a rather vague notion of the extent to which the federal government has entered the field of construction, including the design, installation, and financing of heating, piping, and air conditioning systems.

But who are all these agencies? How do they operate? *Where* are they? And how do they affect the business of engineers involved in federally constructed or financed projects?

In the following pages, a well-known HP-AC author outlines the types, functions, and regulations of the government bodies the engineer may encounter when he "goes to Washington."

REGARDLESS of Presidents, administrations, or the political complexion of the Congress, federal construction (direct or through grants, loans, mortgage insurance, etc.) steadily increases.

If it declines in one direction it grows in another, so that the net result is always upwards. Consequently, this activity forms an ever increasing percentage of the total construction job on a national scale.

It is therefore of increasing importance for contractors, consulting engineers, and manufacturers to know how things are being done in Washington, and how best to capitalize on the growth — and finally to know where to go in the vast bureaucracy of government to achieve the best results in the least time.

### Legislation May Increase Spending

There has been introduced in the U. S. Senate a bill (S.1478) which if passed will greatly increase the amount of direct and indirect federal aid for housing of one kind or another, both privately and publicly constructed and owned.

The principal factor in this program is the Urban Renewal Administration, a constituent of the Housing and Home Finance Agency — the head of which it is now proposed to raise to cabinet rank.

But URA does not itself erect any buildings. All construction is handled by private investors under Federal Housing Administration (FHA) regulations, or by other government agencies such as the Public Housing Administration. The URA does assist in the financing of the purchase and clearing of the land, and makes up most of the deficit in acquiring, clearing, and re-sale of the land to the actual bidder.

It is also proposed in this bill to increase the Federal investment in mortgages on housing projects through the Federal National Mortgage Association, familiarly known as Fannie Mae.

In a separate bill (S.1425) it is proposed to greatly increase loans for college housing, as administered by the Community Facil'ties Administration.

Together, the two bills seek an *increase* of $4.54 billion for housing, of which $1.485 billion would be used in the next four fiscal years.

Then there is the much publicized large scale public school construction program. How this will be handled has not yet been decided, but it is obvious that it will have considerable impact on the heating and air conditioning industry.

Finally, congressional approval has also been asked for increasing the maximum amount of insurance of housing mortgages and for liberalizing the present terms of the insurance program handled by the FHA.

### Prospect: Big Increases

Thus the prospect is strong for a large step-up in housing and school construction during the life of the present administration. Since government programs are seldom reduced once they are started, the industry can look forward to a greater and greater government hand in this type of construction.

On the other hand, it appears quite certain that there will be a reduction in the building of army, air force, and navy bases both at home and abroad, excluding an unfavorable change in the world picture, and that fewer veterans hospitals will be built.

### How Government Is Involved

There are three main divisions of federally connected work as far as heating and air conditioning are concerned. These are shown in the box on page 119.

### Where Are These Agencies?

Except for the Atomic Energy Commission, the headquarters of these agencies are in the Washington area, but in spite of the massive construction of recent years it is still true that most are not confined to one building. The result is that technical or engineering sections usually are not at the address shown in the telephone book. Unless one knows the location of the man in charge of each branch, a great loss of time can be suffered.

Generally, the head offices in Washington exercise only a supervisory control over construction, acting mainly as consultants to their own regional or division offices. A notable exception is the Veterans Administration, which handles all design and contract awards from its own construction department in the capitol — unless overloaded with work in which case the design is given out to private architects and engineers. Such private professionals are known in government circles as "A-E," and we will use that term hereafter for the sake of brevity.

### How Control Is Exercised

"Supervisory control" can be quite stringent. In the design stage it usually takes the form of a "guide" specification, the use of which may be mandatory (as in the case of the Army Engineer Corps), or only advisory. In the latter instance, the specification will only show what the agency desires, but will be written so that the consulting engineer can lift out sections bodily and incorporate them in his own specifications. This assures proper specifications with no question of approval.

Federal specifications do not use manufacturers' names. Instead, they define construction and performance in considerable detail. Compliance with the details will assure approval. Inattention to the details, from either carelessness or other reason, only leads to disapproval, which in turn is likely to mean

that the contractor or manufacturer is compelled to supply more expensive equipment than anticipated at the bidding stage.

This practice of excluding manufacturers' names, however, is not wholly uniform through the government agencies. For example, the Bureau of Yards and Docks says:

> *"The practice of specifying items by naming an acceptable commercial product, followed by the words 'or equal,' will be permitted under the following conditions*: 1) *there are no government-type specifications for the item,* 2) *the item must be a minor part of the construction project, and* 3) *the item cannot be adequately described because of its technically involved construction. In each instance a minimum of three manufacturers shall be included as part of the required description, followed by the words 'or equal' to assure that the bidding will not be restricted to the particular named manufacturers or suppliers."*

The Public Housing Administration has this to say:

> *"The use of trade names and 'or equal' clauses, except for occasional items of equipment, should be avoided. Such practice is undesirable because a) it indicates a preference for the item named, thereby restricting competition, and b) it opens the way to time-consuming arguments about what is 'equal.' It is much better practice to describe the nature and characteristics of an item and set up a firm basis for competition by establishing the detailed performance it must be capable of producing, or by reference to standard published specifications such as those hereinbefore mentioned."*

**What About Patents, Unique Items?**

Can a patented item, or one produced by only one manufacturer, whether patented or not, be specified? One agency has published a ruling on this, which can be assumed to have proper governmental sanction. It states that such items may be specified if

# Heating, Piping & Air Conditioning Road Map to Washington, D. C.

the contractor has the option of using a competitive item if that is to his advantage, or if the patented item is bid separately and the contract awarded on whichever item is lowest in price, or "*unless it can be demonstrated beyond doubt that for certain necessary uses one material or device only will properly serve the purpose, in which case prior agency approval must be obtained.*"

It is the general rule that heating and air conditioning is included as part of the general contract, and only one price is bid for a job. However, in some states where there are state laws requiring separate bids, this general rule is not adhered to, except that when a job is on federal government property, as an army base, it is considered that state laws do not apply.

Now let us consider each of the various agencies listed in the box as involved in the federally oriented construction programs. The address of each agency is included.

**General Services Administration**

General Services Building, F St. between 18th and 19th Sts., N.W.

*Mr. Robert R. Jones, Chief of Mechanical and Electrical Branch.*

This agency takes care of a great variety of federal buildings, including post offices, federal office buildings, Treasury Department buildings, customs houses, and others.

Most jobs are handled by A-E, but heating and air conditioning specifications are controlled by the agency's standard specifications, supplemented by guide specifications which tell the engineer how to set up his own specifications. Some latitude is allowed, as for example in the type of air conditioning system recommended by the consulting engineer as most suitable for the project. The central GSA office reviews all plans and specifications for the larger projects, and the smaller ones are left in the hands of the 10 regional offices of this agency.

The need for air conditioning, as seen by this agency, is indicated by a map of the United States which shows curves of equal design effective temperatures from 80 to 84 F. This is an arbitrarily constructed index combining design dry bulb temperature and design wet bulb temperature.

Generally, all buildings are air conditioned where the design effective temperature is 80 F or higher. Where it is less than this value, buildings are not normally air conditioned unless they are of the block type or have special operating requirements that necessitate cooling.

Occasionally, essential spaces in a building are air conditioned initially and the system expanded later to the remainder. The agency hopes that eventually all buildings will be air conditioned — and of course

that money will be available to do that.

Another office of the GSA, the Federal Supply Service, takes care of the purchase of operating and maintenance items, often in large quantities and often including items for other agencies. It is intended that this office will ultimately take care of all such purchases for all federal agencies.

### Veterans Administration

Munitions Building. Constitution Ave. at 21st St., N.W.

*N. C. Hepburn, Chief, Design Service Section, Mechanical Division.*

As noted, this agency designs, builds, and operates hospitals for war veterans. The Mechanical Division has developed complete specifications for all items of heating and air conditioning. These embody some details of construction which deviate from the usual commercial practice. Such deviations have been developed from experience in connection with certain requirements, as for instance housing for mental patients. It therefore behooves the contractor to pay particular attention to these specifications, since an attempt to obtain approval of changes may well be merely time wasting.

The Mechanical Division designs the heating and air conditioning systems, or in some cases this is done by the A-E, in which event the plans and specifications are then reviewed and approved by the Mechanical Division in Washington.

### Routing, Standard Practices

Submittals for approval of equipment for projects designed by the Mechanical Division are routed from the heating contractor through the general contractor and to the Construction Service Section in Washington, and are then turned over to the Mechanical Division for comment. Replies are routed in reverse. For projects not designed by this division, the A-E is responsible for approvals.

Since steam is needed at several points in hospitals; for sterilizers, kitchens, etc., it is usually used for heating as well, with convectors, vacuum pumps, and zone temperature control.

Special areas, such as operating rooms, are always air conditioned, but wards, private rooms, nurses' quarters, and so forth are only air conditioned where it is considered that the climate requires it.

### Army Engineer Corps

Chief of Engineers for Military Construction, Building T7, Gravelly Point, Va.

*Mr. B. H. Steinecke, Chief of Utilities Branch, Engineering Division.*

The operation of this branch is most clearly explained in an official document entitled "Statement of Functions," which reads in part as follows:

"1) Prepares manuals, guides and standard specifications, typical and standard drawings and other memoranda to control the design criteria relating to . . . heating and power plants, air conditioning systems, steam distribution systems, mechanical systems for buildings . . .

"2) Reviews plans and specifications prepared by the Corps of Engineers field agencies, Theater and Army Commanders and Technical Services, for se-

## How Government Is Involved In Construction

**Direct construction by government agencies, such as**

1) The General Services Administration, which may be said to construct about all federal buildings not otherwise provided for.

2) The Veterans Administration, which builds veterans hospitals.

3) The Army Engineer Corps, which takes care of all structures on army and air force bases at home and abroad.

4) The Bureau of Yards and Docks of the Navy Department, which builds all land installations for the navy.

5) The Atomic Energy Commission.

**Construction by means of grants or loans to state and city agencies, such as**

1) The Housing and Home Finance Agency, which operates through two sub-divisions: The Public Housing Administration (participates in the financing of low rent housing through local city, county, or regional housing authorities), and The Community Facilities Administration (handles grants for the construction of certain public schools and makes loans for college housing.)

2) The Department of Health, Education and Welfare, which, by grants to state agencies assists in the construction of hospitals and allied facilities.

3) Promotion of housing construction through the federal insurance of bank loans to private builders, this category being composed entirely of the well known FHA.

**Ship construction by the Bureau of Ships, Navy Department, and Maritime Commission.**

This category is not included in this survey because it is outside the activities of the great majority of consulting engineers, contractors, and manufacturers, involving as it does methods of design, construction and installation not commonly used on land.

lected projects, and by A-Es, for technical sufficiency and compliance with construction policies."

This branch does not lay out jobs. That function is left to the A-Es who are selected by the District offices subject to approval by the Division offices. Included are all types of buildings to be found on army and air force bases, from hangars to hospitals.

The use of the guide and standard specifications and drawings prepared by the Utilities Branch is mandatory on the A-E. Approval of the A-E plans and specifications is handled by the District Engineer, who also awards the contracts. The Utilities Branch only enters the picture if requested by the Division Engineer office; generally when a particular design is of an extremely difficult nature.

### Normal Design Practices

For the type of buildings constructed on army and air force bases, finned pipe in cabinets with dampers is commonly used with forced hot water circulation. When unit heaters and similar equipment is used, steam is the usual medium, especially if outside air for ventilation enters the unit.

Air conditioning is permitted only in specified areas shown in an army regulation (AR 420-54) dated March 4, 1959.

High temperature hot water at 300 to 400 F is widely used for central plants and distribution, and is usually converted to 200 F water in each building, but is sometimes used direct for large space heaters. For central plants requiring something less than 1000 boiler hp, steam is generally used, either high pressure (100 psi and up) or low pressure (15 psi).

### Bureau of Yards and Docks

Navy Department, Memorial Drive, Arlington, Va.

*Mr. A. L. Graul, Head, Mechanical Specifications Section.*

This bureau is responsible for the construction of

# Heating, Piping & Air Conditioning Road Map to Washington, D. C.

all shore installations for the navy. The majority of jobs are designed by A-E in the area where the work may be located, based on their qualifications and experience. However, the Specifications Branch has prepared standard specifications which are utilized by the A-E as far as applicable. These specifications are of two kinds:

a) The TS series, which are written so that they can be copied into the job specifications.

b) The Y series, used as reference without being written into the job specifications.

Numerous MIL and federal specifications as well as commercial codes and standards are also included by reference.

The District Public Works Office receives bids and awards contracts and likewise makes all approvals.

Steam is generally used as the heating medium, but there is an increasing use of high temperature hot water for central plants and distribution. Air conditioning is not generally included and is used only where there is some urgent need for it.

### Atomic Energy Commission

Germantown, Md.

*Mr. K. A. Simmons, Mechanical Engineer, Construction and Supply Division.*

A guide manual has been prepared establishing criteria for heating and air conditioning systems, but this consists largely of reference to various federal specifications and commercial practices, codes, and standards. The design of each project is generally left to the A-E retained by the project managers in the field offices. Process air conditioning, mainly having to do with the removal of heat and humidity, is much more of a factor than comfort air conditioning, which forms but a very small part of the total work approved by the AEC.

### Housing and Home Finance Agency

As noted earlier this is one of the devices by which the government effects construction through grants or loans to state and city agencies. The Housing and Home Finance Agency operates through two subdivisions, the Public Housing Administration and the Community Facilities Administration. These will be considered separately.

### Public Housing Administration

Longfellow Building, 1741 Rhode Island Ave., N. W.

*Mr. Nathan Levy, Technical Branch*

This agency may lend financial and technical assistance to local housing authorities established by state legislation, to develop low rent housing for families of low income. The projects are initiated, planned, constructed, owned, and operated by the

local authorities. PHA lends the money for construction, which is later repaid out of the public sale of housing bonds. PHA guarantees these bonds by paying to the local authority the difference between the annual cost of amortizing the capital indebtedness and the amounts available out of operating income to meet such costs.

Design for these projects is handled by the A-E retained by the local authority, within limits established by the PHA. For this purpose, a guide specification (Division 27, November 1960) has been prepared for heating. None of the projects have been air conditioned as yet.

The guide is advisory, not mandatory, but to quote from the preface "it is felt that its use is highly desirable because PHA experience, as well as that of competent professional and commercial organizations, is reflected in it."

This guide is quite detailed, covering some 67 pages, but its length is due in part to the inclusion of boiler plants, underground distribution, and steam and hot water heating, as well as in many cases several different methods to obtain the same end, such as in heating system controls.

### Bidding, System Selection

Construction bids are received and opened by the local authority, which awards the contracts subject to approval of the regional office in whose territory the job is located. The entire procedure takes place at the local level, and only in the case of some difficulty is a job referred to Washington headquarters.

Selection of steam or hot water as the heating medium is left to the A-E, and there is no agency policy in this respect. Regional offices, however, often influence the choice.

High rise buildings are apt to be steam heated, and in some regions steam is preferred for all jobs, while in others the preference is for hot water. Similarly the type of heating system control varies according to the size of the job and the local practice, plus the assumed experience of the A-E.

The guide specification used by PHA contains one requirement which has sometimes been overlooked, much to the sorrow of those concerned. No heating effect factor is allowed in figuring the capacity of convectors or baseboard radiation. Some manufacturer's catalogs list this effect at a value as much as 15 percent.

## Community Facilities Administration

1230 16th St., N.W.

CFA assists in the financing of college housing projects and in the construction of certain public schools which are attended by children of federally-connected families. However, the design of heating and air conditioning systems for such jobs is left up to local A-E, and there is no guide specification. Approval of plans is handled by regional offices of this agency.

## Federal Housing Administration

Architectural Standards Division

Lafayette Building, 811 Vermont Ave., N.W.

*Mr. Charles B. Droba, Mechanical Engineer*

Contrary to a commonly held idea, this agency does not grant or loan any money, but only insures approved bank mortgages for the construction of private dwellings, either single or multi-family.

There is a guide specification, called Minimum Property Standards No. 300, which is designed to protect the FHA against involvement in mortgage insuring on buildings of inferior or defective construction. For this purpose, the guide sets forth minimum standards rather than the complete details of construction. It includes the same restriction on the use of heating effect factor mentioned above.

All jobs are designed by the A-E and approved in one of the 75 offices in the 50 states and Puerto Rico.

## Dept. of Health, Education, & Welfare

Public Health Service

Division of Hospital and Medical Facilities

Tempo R Building, Jefferson Drive at 4th St., S.W.

*Mr. Richard P. Gaulin, Supervisory Mechanical Engineer*

Grants of federal funds to state agencies are made by this unit for the construction of general hospitals and related health facilities, mostly in rural areas which lack such facilities and are unable to obtain them without government aid.

The program is quite extensive, representing the construction of 600 to 650 projects per yr, and as the rural need becomes increasingly satisfied, more hospitals may be built in urban areas.

Design is handled by private A-E subject to conformance to the individual state laws and to Public Health Service Regulations (part 53, revised December 29, 1959) which briefly outlines the rather complicated requirements of hospital service.

The program is administered at the local level by the state agencies and the eight regional offices of the Public Health Service.

A majority of new buildings are being air conditioned, using standard types of systems with a trend toward high velocity induction units. To reduce the possibility of the spread of airborne contamination and to provide required conditions for specific areas, systems are usually designed to limit the air movement between rooms or departments. This practice often involves pressurizing the corridors. ⫩

By JOSEPH H. JERRELL
Design Engineer
Leo S. Weil & Walter B. Moses, Inc.
Consulting Engineers

**How to diagnose and treat a comfort-robbing malady common to department stores and similar structures, when hot and cold spots, drafts, and "inadequate" cooling and heating indicate that the disease is**

# Negative Pressure In An Air Conditioned Building

DEPARTMENT STORES are particularly susceptible to a disease which strikes air conditioning systems called "Negative Building Pressure." The malady is fairly easy to cure, and its symptoms should be fairly obvious, but it is surprising how often it occurs and even more surprising how frequently the real trouble is incorrectly diagnosed.

### Access Areas Suffer First

The first symptom usually appears at the store entrances. What was once a satisfactory entrance heating arrangement no longer seems adequate on a winter day. Yet, the same quantity of air is being delivered to the entrance at the same temperature.

What has happened is that so much air is being exhausted from the building that the air pressure inside is lower than outside, and outdoor air enters through the doors to balance this partial vacuum.

### Treatment Is Obvious

Any air conditioning engineer knows that, in order to combat infiltration, it is necessary to introduce a certain amount of outside air into the air conditioning system. Some people believe that the sole purpose of this outside air (frequently but improperly called "fresh") is to sweeten the atmosphere in the store — to reduce odors, bacteria count, and staleness.

However, an equally important reason for outside air intake is to reduce the infiltration of air *directly* into the building. Outside air introduced through the air conditioning system is first treated (heated and humidified in winter; cooled and dehumidified in summer) so that the air actually enters the occupied areas at the same temperature and humidity as does the rest of the air supply.

### Contrast of Direct Intake

This is in contrast with infiltrated air, which creates the discomforts of cold drafts in winter and hot spots and moisture condensation in summer. In either case, the load on the year 'round air conditioning system is about the same, since most of the outside air must eventually enter the air handling equipment. With infiltration, however, the outside air is conditioned only after it has created objectionable conditions in the store.[1]

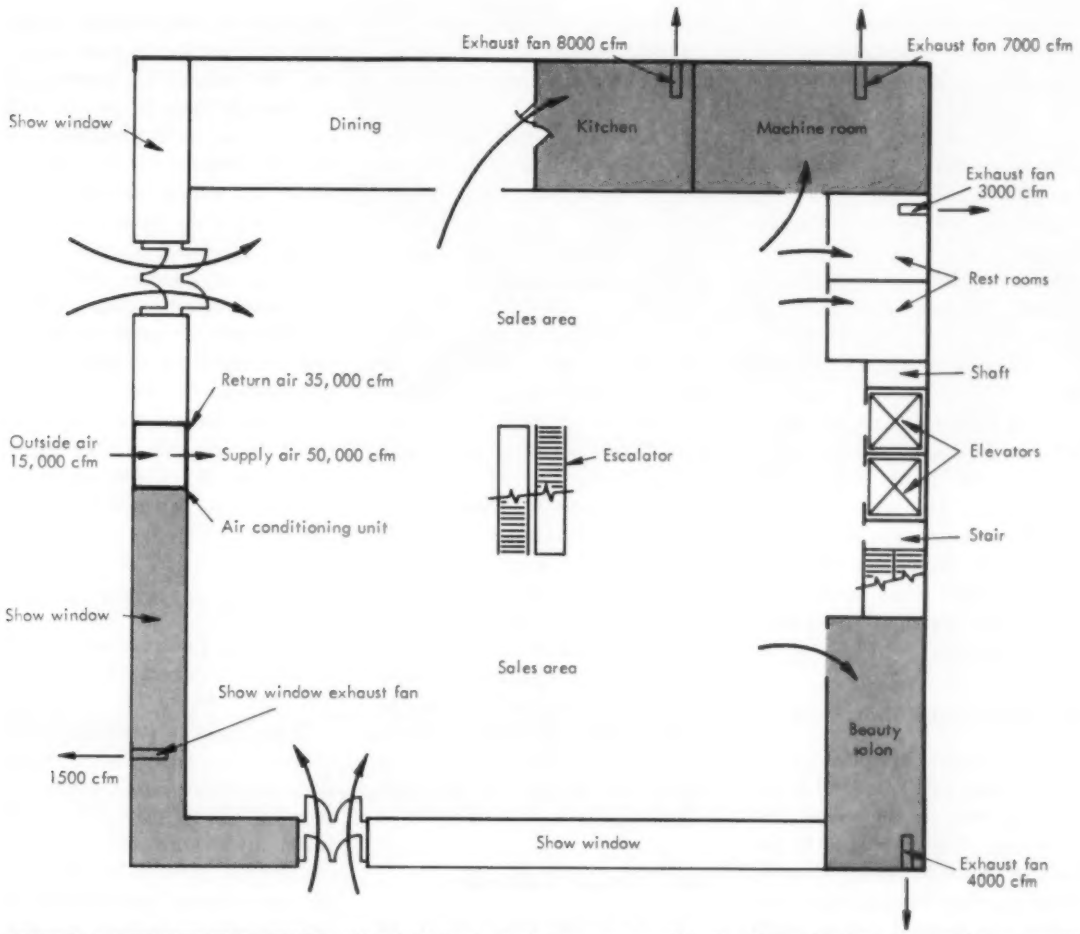
### Problem Is Excess Exhaust

The cause of excess infiltration and its attendant annoyances is obviously too much air exhaust. A store will often attempt to get something for nothing by exhausting air from the conditioned spaces through service areas. Of course, such air is not actually free, as it must be replaced with air from the outside.

### Exhaust Grows Unchecked

Fig. 1 illustrates the ultimate condition of a store with an air

[1] *Introducing outside air via the air conditioning units can provide an added, intangible benefit to the store operator over and above the prevention of infiltration. In summer, air leaving through store entrances is conditioned and therefore pleasant. A cool breeze flowing from the store onto sun-baked window shoppers can be most enticing, and should attract a number of potential impulse buyers. This is "outdoor advertising" at practically no extra cost.*




**1 TYPICAL DEPARTMENT STORE which initially had adequate air conditioning for principal areas. Raid on conditioned air supply for exhaust through fringe areas (gray) results in negative inside pressure, direct intake of outside air**

exhaust system which kept growing. The equipment shown might be located anywhere in a multistory building; because of open stairwells, elevators, etc., the problem remains basically the same.

In this store, the air conditioning equipment handles 35,000 cfm of recirculated air plus 15,000 cfm of air from the outside, for a total conditioning load of 50,000 cfm.

## Original Plan Was Sound

For the time being, let us ignore the exhaust fans. As a result of the fact that the air conditioning unit supplied 15,000 cfm in excess of what it drew back from the store, a positive building pressure was maintained. The excess 15,000 cfm of air tended to flow from the store outward through the doors as well as through other relief areas such as elevator shafts, pipe shafts, and penthouse louvers. This gave the desired results of minimum infiltration and maximum exfiltration.

## How Susceptibility Increased

To see how the store exposed itself to the negative pressure disease, let us follow the developments after the original system was installed. The consulting engineer who designed the system may have taken into consideration the rest room exhaust fan with a capacity of 3000 cfm. The source of air for all other exhaust systems initially included was from the outside, and did not affect the design air quantities.

A proper conclusion was that there would be an excess of 12,000 cfm for exfiltration to the outside. In the beginning, therefore, the system worked well.

## The Raid Begins

After the system was put into operation, it was decided to allow some of the cool air from the sales area to be drawn through the kitchen by the exhaust fans. This was not in accordance with the original plans, but conditions in the kitchen were improved so much that it was decided to take all of the 8000 cfm of exhausted air from the conditioned areas.

The raid on the conditioned air supply then followed a typical pattern: a new beauty salon demanded 4000 cfm for odor removal, the machine room 7000

cfm for comfort cooling, show windows and miscellaneous exhaust systems another 4000 cfm.

By now the store was experiencing a bad case of negative building pressure. The 11,000 cfm deficiency between the amount exhausted and the outside air being introduced not only caused infiltration and its annoyances, but imposed an additional load of about 40 tons of air conditioning not contemplated in the original design.

Thus, instead of "getting something for nothing," the store had manufactured many more problems than it had solved. By the time the management took cognizance of the complaints, the operating engineer found himself besieged with "solutions" from nearly every quarter.

### Half Measures Won't Work

Since the first symptom to appear is often cold spots and drafts near an entrance in winter, the immediate corrective step is frequently the installation of additional entrance heating. For some reason, the original system which worked well no longer does the job, and so the fan is speeded up or coil capacity is increased.

Next, supply air distribution is often changed or rebalanced in an effort to effect relief for the complaining areas.

Another "solution" frequently attempted is to reduce the amount of outside air taken into the air conditioning unit, for store ventilation; with the thought being that by relieving the unit of outside air load, cooler supply air will be available in the critical areas.

This last is *surely* no solution, and in fact, any of these desperate measures will result in disappointment unless the true cause of the trouble has been identified.

### Diagnosis Procedures

An air conditioning consultant called into such a situation would very likely do the following:

1) Determine the required capacity of the air conditioning system

2) Establish what percentage of air supplied to the building by the air conditioning units is outside air, and

3) Determine the total amount of air exhausted and whether the exhausted air comes from conditioned areas directly or indirectly.

He would then make one or more of the following recommendations:

1) *Make necessary changes in the exhaust system.*

List the capacity of all exhaust fans, and determine which of these take air from conditioned spaces. Kitchens, mechanical equipment rooms, painting and carpentry rooms, and other work areas, which were originally ventilated by means of outside air, must be studied for possible system changes which have increased the amount of air taken from conditioned spaces.

### May Change Capacities

2) *Revise the design of the air conditioning unit as required.*

An examination of the air conditioning system will reveal the fan, coil, and refrigeration capacities, and the amount of conditioned outside air supplied to the store through the unit. The automatic control system must also be checked to be sure that no restriction of air flow exists because of faulty damper action. If such a survey indicates that the system has unused capacity available, the percentage of outside air taken into the unit may be increased; otherwise a change in system design must be considered.

3) *Install separate air handling units in areas where the demand for more comfortable working conditions no longer permits the use of outside air for ventilation.*

In certain areas it will not be possible to maintain comfort conditions with outside ventilating air, and yet the existing equipment may not be adequate to permit the exhaust of conditioned air through these spaces. In such cases, special cooling-heating units may be designed for these spaces. These will supply outside air as required for the exhaust systems, but will recirculate as much as is practical in order to reduce the refrigeration and heating load.

If the units are properly selected and controlled for limited cooling and heating, the building system will have no greater load than would be imposed by the excess infiltration of outside air when store air is exhausted through these rooms.

### Watch for Stack Effect

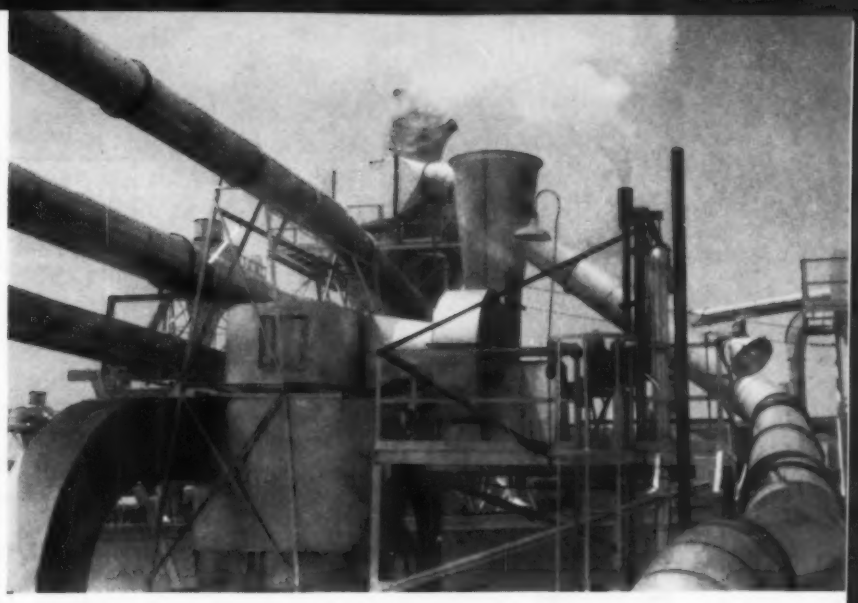
4) *Investigate the possible loss of store air caused by "stack effect."*

Stack effect is another contributing factor, mainly with regard to lower floors during the winter months. This is the tendency for warm air to rise and relieve to the outside through openings on the upper floors. Such leaks should be eliminated wherever possible, with care exercised so as not to close any openings required by the various codes.

### After Cure, Prevention

As a final recommendation, after a positive pressure has once more been restored, any future requests for exhaust systems should be carefully appraised, so that the air balance necessary for good department store air conditioning will be maintained.

Store managements must be made aware of the fact that exhaust fans are not always the most satisfactory nor the most economical method of providing comfortable conditions in service areas. When an air conditioning system is not performing up to expectations, an investigation of the exhaust systems will often be most revealing. ⧺



EXHAUST STACKS from steam turbine operated fans on plywood core and face material dryers stand amidst complex steam and hot water piping systems needed for flake board manufacture

# Economy, Conservation Keynote Process Piping, Heating Systems

## — *in new flake board production plant*

- Steam-to-HPHW
- Steam turbine drives
- Dual-purpose pumps
- Spot heating
- Reconversion: HPHW-to-steam

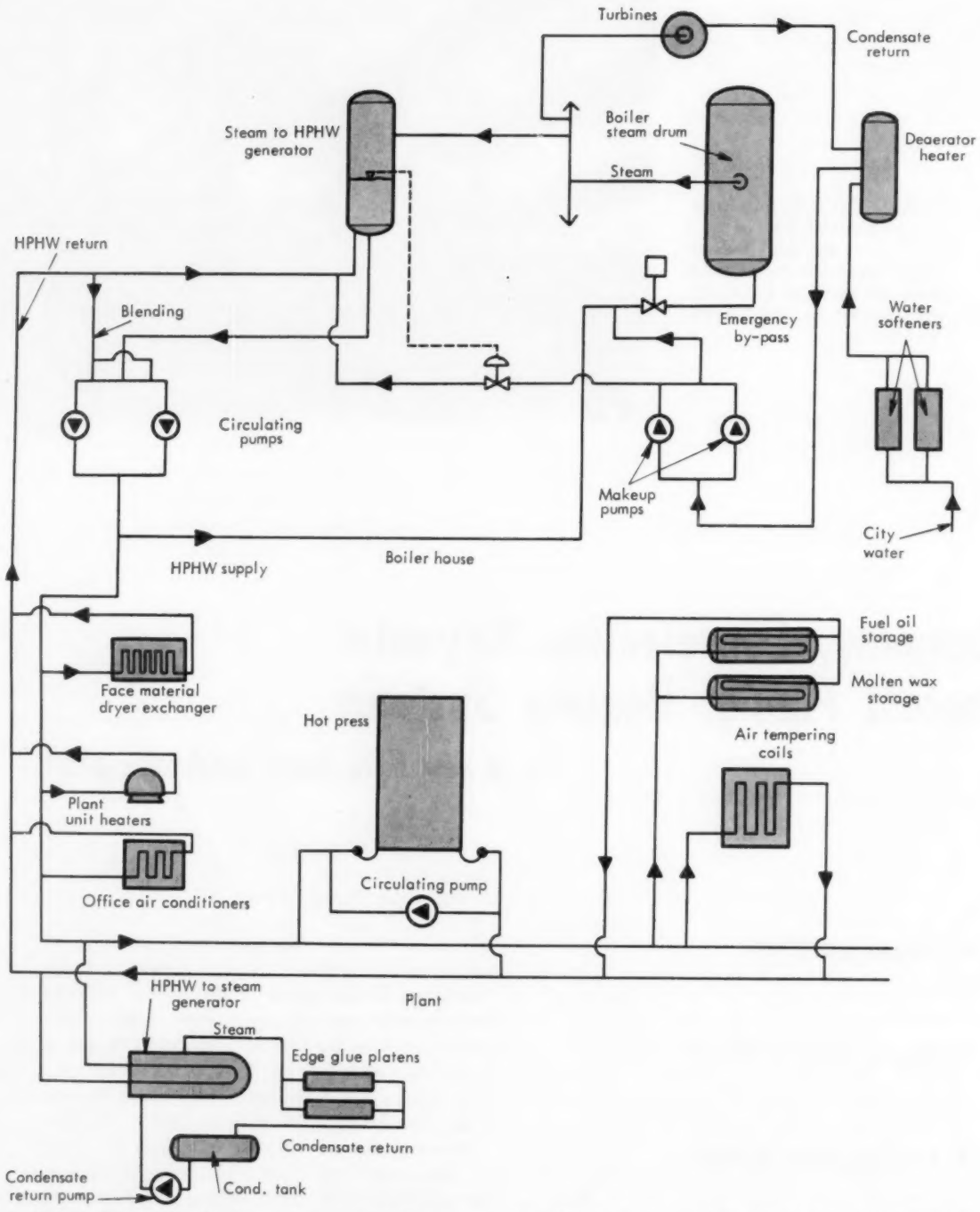
By WILLIAM F. SMOOTS
Mechanical Engineer
United States Plywood Corp.

IT'S AXIOMATIC that any good production line not only turns out a quality finished product, but uses "everything but the squeal" along the way. Everyone has been made aware, in recent years, of the pressing need to conserve our natural resources, including of course, the fuels.

We believe that in the new United States Plywood Corp. flake board plant at South Boston, Virginia, true conservation is practiced — both in the use of the wood raw material and in the design of the heating and the process piping systems which serve the plant.

### The Plant

This facility will use some 50,000 cords of wood per year to manufacture 30 million sq ft (¾ in. basis) of a three-ply board, using wood chips for the center core and wood flakes for the two surfaces. To provide heat for both comfort and the various drying and compressing operations, J. O. Ross En-




**1 FLOW CHART** for heating and process piping systems in new United States Plywood Corp. particle board plant at South Boston, Virginia, reveals the extent to which careful planning and installation can get the most from an investment for this kind of industrial job. At upper right, water tube two-drum boiler produces 35,000 lb of steam per hr at 250 psig operating pressure, plus 20 million Btu per hr in furnace gases. Latter heat is used to supply a dryer in the processing of wood core material. Steam is converted to high pressure hot water in generator at upper left. HPHW (395 F) is supplied to a wood face material dryer, to various unit heaters for spot heating throughout the plant, and to office air conditioners. Main demand on the line however, is for the plywood hot press (12 million Btu per hr peak, with 4 million Btu per hr mean load over duration of 15 minute cycle). Hot water is also used in a converter to generate 500 lb of steam per hr at 150 psig for use in an edge glue press. Finally, HPHW supplies heat for fuel oil and molten wax storage tanks, and for outside air tempering coils. Multi-purpose plan was used wherever possible — for instance hot water circulating pump also serves as boiler feed pump; excess steam drives dryer fans, boiler fans, and a makeup water pump. Pump and boiler fan turbines exhaust to deaerator

"Waste" wood supplies the energy — steam yields process heat, is converted to high pressure hot water for use in pressing, drying, and comfort heating — pumps serve a dual function — process water is reused for log cleaning — hot water generates more steam for flake drying — furnace gases remove water from wood material.*

gineering designed a combination steam and high pressure hot water system to utilize to the fullest the energy available.

We were faced with the following heat requirements:

1) Plant heating and process tempering air (6 million Btu per hr);

2) Panel press using water at 350 F (and 330 F return) with an average load of 4 million Btu per hr but with a peak load of three times this amount at the start of the press cycle;

3) Face material dryer (7 million Btu per hr);

4) Core material dryer (20 million Btu per hr);

5) Edge glue press requiring 500 lb of steam per hr at 150 psig;

6) Miscellaneous plant heat loads.

### Utilize Wood Waste

We estimated that the wood refuse products from the various production processes could yield a total of about 85 million Btu per hr — more than enough to supply the demand. By this means, we are able to put to use the fines, saw dust, sander dust, hogged trim ends, and bark that accumulate in preparing and finishing the wood.

### Flow Chart

The flow chart of Fig. 1 shows the layout of the combination system finally developed.

The boiler is a water tube, two-drum type designed to produce 35,000 lb of steam per hr at a 250 psig operating pressure, plus 20 million Btu per hr furnace gases. The latter heat supply is used for the core material dryer for tempering during the drying operation, and is supplemented, if necessary, by outdoor air. Thus, one problem was solved.

Steam, at 230 psig, from the boiler is introduced together with return water into a steam-to-high-pressure-hot-water generator, the bottom portion of which serves as an expansion reservoir for the hot water system, and also as a storage reservoir for the boiler feed.

### Pump Serves Double Function

Water at 395 F is circulated from the generator to the plant and back to the generator by a pump which also serves as the boiler feed pump. This is possible because the pressure in the generator is identical to that in the boiler. Therefore, pumping back to the boiler only requires that the resistance of the boiler water level control valve and the branch from the low head circulating pump be overcome.

Some of the continuous blowdown from the boiler is introduced into the HPHW system. By this means, the concentration and alkalinity of the boiler water is maintained within the required tolerances, while at the same time the alkalinity of the otherwise salt-starved high pressure hot water system is increased, eliminating a possible corrosive condition.

### Dryer Is First On the Line

The first substantial user connected to the hot water distribution system is the face material dryer. This hot-water-to-air heat exchanger requires 346 gpm with a temperature drop of 35 F through the coils. Air passing through the coils is heated to about 370 F, and dries the face material to an approximate 35 percent moisture content. Hot water flow is controlled by the dryer outlet air temperature.

### Hot Press Is Main Load

Particular care was required in the design of the system serving the hot press, which represents the principle load on the line. The press operates in a 15 minute cycle, with an initial peak demand of over 12 million Btu per hr. A mean load over the duration of the press cycle is 4 million Btu per hr. The inlet temperature to the press is maintained at a set value by blending return water with supply water from the header through a three-way valve. Flow through the press is at a rate of 1200 gpm.

*For some useful additional comments on how careful design and foresight has resulted in many economies on similar wood-product production lines, see *Good Piping Practice Pays Off in the Lumber and Plywood Industry*, by William D. Lesher, HPAC, October 1960

FUEL BIN for plant receives "waste" wood via conveyor system seen at left

DUST COLLECTORS reclaim waste from sanding operations for use as fuel

A supply header for the plant comfort heating system is tapped from the main supply line at a point between the face material dryer and the hot press.

### Unit Heaters Give Spot Heating Only

Unit heaters of the bottom discharge variety are equipped with hot water coils and mounted at a height of 20 ft. The heaters are arranged to provide spot heating only, as it would be uneconomical to provide enough heated air to offset the loss through the material handling fans and the press fume exhaust fans required by the board-making operations.

Outdoor air tempering coils are provided also, both for hot press ventilation and for the "board cooler," to prevent warpage from too-rapid cooling.

### All-Steam System

Steam generated in the boiler, besides being used in the hot water generator, is used directly for several purposes in the plant. Steam turbines are used to drive the two dryer fans, the forced and induced draft boiler fans, and one of the makeup water pumps. This gives the boiler a high base load to absorb the fluctuations in the requirement for hot gases at the dryer and hot water at the press. Steam drive also affords flexibility in fan speed for drying, and in the case of the makeup water pump, an added margin of safety in case of electrical failure.

Boiler fans and the makeup pump turbines exhaust to the deaereator, while the dryer turbines exhaust directly to the atmosphere. If experience indicates the need for more heat in the deaereator, the dryer turbines can also be connected to that unit.

### Systems Are More Complex

The decision to use steam drive turbines, however, did add somewhat to the complexity of the design. The feed water makeup pump and system were increased in capacity, and the boiler feed piping had to be extended somewhat and a deaereator tank and chemical feed unit added.

### Reconvert to Steam

Another part of the board-making process utilizes a single-opening, edge glue press which requires 500 lb of steam per hr at a pressure of 150 psig. This steam supply is generated in a heat exchanger supplied with high pressure hot water at 390 F. Steam pressure is regulated by an indicating controller which operates the valve from the hot water main. Condensate from the glue press discharges into a closed receiver, from which it is pumped

back to the generator. Makeup is manual by means of a valve to the hot water return line.

Finally, hot water is delivered to two storage tanks for fuel oil and molten wax heating, and is returned to the boiler house. Wax for the gluing operation is heated from 200 F to 300 F before delivery to the glue deck.

### Materials, Methods

All piping for the HPHW system is Grade A carbon steel, Schedule 80 with screwed ends or Schedule 40 with welded ends in lines 1½ in. or less. Pipes 2 in. or more in diameter are of Schedule 40 with welded joints.

Piping for steam, condensate return and compressed air (100 psi or less) is Schedule 40. All hot water and steam pipes subject to pressure were given a hydrostatic test at 375 psig for 6 hr.

### Compressed Air System

The plant compressed air is supplied by a 500 cfm, horizontal single stage compressor, water cooled, with after-cooler, moisture and oil collector, and an air receiver tank with automatic moisture trap. Dual controls include a high temperature water shutdown switch.

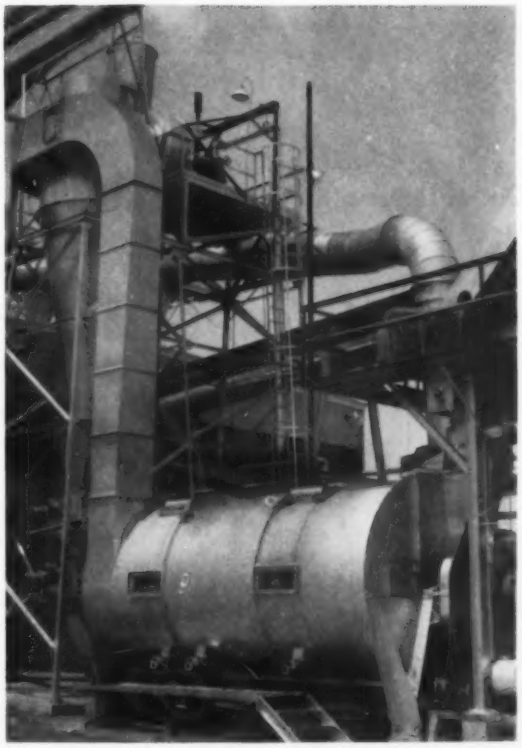
Compressed air is piped from the boiler house to the plant through a 4 in. line over the same path which accommodates the hot water supply and return lines. At a central point in the plant, the utility air system is supplied through a back pressure relief valve. This valve is set so that the utility system gets air only when the plant process air system is above 60 psig. Process air is used for controls, cylinder control and actuation, glue atomization, and other purposes. Utility air is used principally for cleaning.

### Cold Water Service

Process and domestic water are supplied by the city through a single 4 in. main. Each system has a meter, since the domestic water is returned to the city sewage system and is supplied at slightly higher rates.

Process water, after it has been used for cooling and cleaning, is collected in a large pond, where it is further utilized as a spray for logs held in storage.

Piping contractors for the new plant were Wachter & Wolfe Co., and J. O. Ross Engineering. The latter firm also designed the systems. International Caliqua Corp. of Vienna was retained for consulting and checking of the boiler plant and hot water system preliminary proposals and general design data. ∓



FACE MATERIAL dryer uses water at 395 F in water-to-air heat exchanger

PIPING, water, steam, and air, is carbon steel, Schedule 40 and Schedule 80

Direct reading tables (Part 3) let you

# Calculate Solar Irradiation Rate For Forward-Inclined Walls

by F. W. HUTCHINSON
Prof. of Mechanical Engineering
University of California, Berkeley

and

M. O. COTTER
Engineering Consultant

THIS is the third in a series of articles covering clear-day irradiation of forward inclined walls[1]; this is also the twelfth and concluding article of a comprehensive group published in Heating, Piping & Air Conditioning over a 10 yr period[2].

## What Tables Accomplish

Together, these articles permit tabular determination, by direct reading, interpolation, or extrapolation, of clear-day direct solar irradiation rates on a surface facing any point of the compass, at any time of day and in any latitude in continental United States, whether the surface is vertical, horizontal, or inclined either toward or away from the sun, or from the vertical.

## Use of Present Tables

The tables of the present article are for the calculation of solar irradiation rates on southeast or southwest-facing, forward-inclined surfaces. Values given here are based on angles of incidence calculated by the method described in the May 1961 issue. Values for the selected hourly normal intensity, $I_o$, have been evaluated by the method described in the article presented in HPAC in August 1955.

The following examples show some of the ways of using the accompanying tables.

### Example 1:

Determine the equivalent refrigeration load represented by the direct, clear-day irradiation of a 5 ft by 8 ft window located in a wall which faces southeast, at latitude 30 degrees, if the unshaded window has a 15 degree forward slope. Determine also the time and amount, in tons of refrigeration, of the maximum imposed solar load and evaluate the average load, in tons, for the daylight hours during July.

*Solution*: From Table 9c, column 6, the maximum rate of gain occurs at 9 a.m. in January and in November, and amounts to 215.3 Btu per sq ft per hr. Total irradiation of the window is at a

[1]The first and second articles in the present series were presented in the April and May, 1961, issues, and covered walls facing south and east or west, respectively.

[2]Irradiation of *vertical* walls was covered in two previous series: for the months October through April in the July, 1949, December 1950, and May 1951 issues; and for the months May through September in the issues of September, October, and November 1954.

Irradiation of *backward* inclined surfaces was covered in a series of three articles which appeared in the August, September, and October 1955 issues.

**TABLE 1 — MAXIMUM HOURS OF POSSIBLE IRRADIATION for vertical walls, given below, may be modified for use in calculating for inclined walls by reference to the incidence angles given in accompanying Tables 9C, 10C, 11C, and 12C**

| Southeast or southwest facing | Latitude, degrees | | | |
|---|---|---|---|---|
| | 30 | 35 | 40 | 45 |
| December | 8.0 | 9.1 | 7.8 | 7.8 |
| January | 8.1 | 8.9 | 7.8 | 7.9 |
| February | 8.0 | 8.0 | 8.2 | 8.0 |
| March | 7.8 | 7.8 | 8.4 | 8.2 |
| April | 7.6 | 8.4 | 8.8 | 8.4 |
| May | 8.6 | 8.8 | 9.4 | 9.2 |
| June | 8.9 | 9.1 | 9.7 | 9.4 |
| July | 8.9 | 9.1 | 9.7 | 9.5 |
| August | 9.0 | 9.3 | 9.7 | 9.5 |
| September | 9.1 | 9.3 | 9.6 | 9.5 |
| October | 7.9 | 8.0 | 8.2 | 8.0 |
| November | 8.1 | 8.9 | 7.8 | 7.9 |

rate of 5 × 8 × 215.3 or 8612 Btu per hr. By definition, cooling at a rate of 12,000 Btu per hr corresponds to one ton of refrigeration, so the maximum cooling load due to the window would be at a rate of 8612/12,000 = 0.72 tons.

Irradiation during July, from column 6, occurs only in the morning hours and at an average rate of (43.2 + 83.7 + 91.0 + 78.8 + 48.8 + 8.4)/6 = 59 Btu per hr. Refrigeration load therefore averages, during July, (5) (8) (59)/12,000 = 0.20 tons.

**Example 2:**

Taking the absorptivity of a water surface as unity, estimate the maximum rate of evaporation from a 100 ft by 200 ft cooling pond that is mounted on the roof of an office building located in latitude 30 degrees. As a rough approximation, assume that the water is at an equilibrium temperature such that all of the absorbed radiation is used to supply

**Southeast or Southwest Wall** — **TABLE 9c** — **Latitude 30°**

| Solar time | | 15° Slope forward | | | 30° Slope forward | | | Horizontal | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Southeast Southwest | $I_o$ | i | cos i | $I_o$ cos i | i | cos i | $I_o$ cos i | i | cos i | $I_o$ cos i |
| **December** | | | | | | | | | | |
| 8am, 4pm | 194.0 | 28 | 0.8843 | 171.6 | 42 | 0.7414 | 143.8 | 79 | 0.191 | 37.0 |
| 9am, 3pm | 265.0 | 36 | 0.8067 | 213.8 | 51 | 0.6267 | 166.1 | 69 | 0.358 | 95.0 |
| 10am, 2pm | 286.0 | 46 | 0.6979 | 199.6 | 60 | 0.4954 | 141.7 | 61 | 0.485 | 138.5 |
| 11am, 1pm | 296.0 | 57 | 0.5503 | 162.9 | 70 | 0.3395 | 100.5 | 55 | 0.574 | 169.7 |
| 12 noon | 298.7 | 67 | 0.3898 | 116.4 | 79 | 0.1881 | 56.2 | 53 | 0.602 | 179.7 |
| 1pm, 11am | 296.0 | 77 | 0.2231 | 66.0 | 87 | 0.0462 | 13.7 | 55 | 0.574 | 169.7 |
| 2pm, 10am | 286.0 | 86 | 0.0643 | 18.5 | * | * | * | 61 | 0.485 | 138.5 |
| **Jan. or Nov.** | | | | | | | | | | |
| 7am, 5pm | 80.0 | 28 | 0.8814 | 70.5 | 39 | 0.7755 | 62.0 | 87 | 0.052 | 4.2 |
| 8am, 4pm | 218.0 | 30 | 0.8628 | 188.1 | 45 | 0.7122 | 155.3 | 77 | 0.225 | 49.1 |
| 9am, 3pm | 277.0 | 39 | 0.7774 | 215.3 | 54 | 0.5877 | 162.8 | 66 | 0.407 | 112.7 |
| 10am, 2pm | 294.0 | 48 | 0.6643 | 195.3 | 63 | 0.4530 | 133.2 | 58 | 0.530 | 155.8 |
| 11am, 1pm | 304.0 | 59 | 0.5191 | 157.8 | 73 | 0.3001 | 91.2 | 52 | 0.616 | 187.2 |
| 12 noon | 308.0 | 69 | 0.3569 | 109.9 | 82 | 0.1476 | 45.5 | 50 | 0.643 | 198.0 |
| 1pm, 11am | 304.0 | 79 | 0.1862 | 56.6 | * | * | * | 52 | 0.616 | 187.2 |
| 2pm, 10am | 294.0 | 88 | 0.0331 | 9.7 | * | * | * | 58 | 0.530 | 155.8 |
| **Feb. or Oct.** | | | | | | | | | | |
| 7am, 5pm | 232.0 | 36 | 0.8089 | 187.7 | 47 | 0.6875 | 159.5 | 82 | 0.139 | 32.2 |
| 8am, 4pm | 251.0 | 37 | 0.7938 | 199.2 | 51 | 0.6287 | 157.8 | 72 | 0.309 | 77.6 |
| 9am, 3pm | 286.0 | 45 | 0.7111 | 203.4 | 60 | 0.5075 | 145.1 | 61 | 0.485 | 138.7 |
| 10am, 2pm | 301.0 | 54 | 0.5847 | 176.0 | 69 | 0.3549 | 106.8 | 51 | 0.629 | 189.3 |
| 11am, 1pm | 308.0 | 64 | 0.4315 | 132.9 | 79 | 0.1940 | 59.8 | 44 | 0.719 | 221.3 |
| 12 noon | 313.5 | 76 | 0.2408 | 75.5 | 89 | 0.0106 | 3.3 | 40 | 0.766 | 240.2 |
| 1pm, 11am | 308.0 | 86 | 0.0760 | 23.4 | * | * | * | 44 | 0.719 | 221.3 |
| **Mar. or Sept.** | | | | | | | | | | |
| 7am, 5pm | 157.0 | 47 | 0.6762 | 106.2 | 57 | 0.5411 | 85.0 | 76 | 0.242 | 38.0 |
| 8am, 4pm | 223.0 | 50 | 0.6385 | 142.4 | 63 | 0.4548 | 101.4 | 64 | 0.438 | 97.8 |
| 9am, 3pm | 258.9 | 55 | 0.5738 | 148.6 | 69 | 0.3529 | 91.4 | 53 | 0.602 | 155.6 |
| 10am, 2pm | 274.6 | 64 | 0.4356 | 119.6 | 79 | 0.1886 | 51.8 | 41 | 0.755 | 207.2 |
| 11am, 1pm | 283.3 | 74 | 0.2701 | 76.5 | 89 | 0.0148 | 4.2 | 32 | 0.848 | 239.4 |
| 12 noon | 286.5 | 84 | 0.1048 | 30.0 | * | * | * | 29 | 0.875 | 250.8 |
| **Apr. or Aug.** | | | | | | | | | | |
| 6am, 6pm | 69.0 | 60 | 0.5047 | 34.8 | 65 | 0.4196 | 29.0 | 83 | 0.122 | 8.4 |
| 7am, 5pm | 202.8 | 59 | 0.5108 | 103.6 | 69 | 0.3617 | 73.4 | 69 | 0.358 | 72.8 |
| 8am, 4pm | 241.0 | 60 | 0.4996 | 120.4 | 72 | 0.3057 | 73.7 | 58 | 0.530 | 127.7 |
| 9am, 3pm | 270.4 | 67 | 0.3950 | 106.8 | 81 | 0.1613 | 43.6 | 44 | 0.719 | 194.5 |
| 10am, 2pm | 282.5 | 73 | 0.2861 | 80.8 | 88 | 0.0317 | 9.0 | 33 | 0.839 | 237.0 |
| 11am, 1pm | 289.4 | 83 | 0.1207 | 34.9 | * | * | * | 22 | 0.927 | 268.3 |
| 12 noon | 290.0 | * | * | * | * | * | * | 18 | 0.951 | 276.0 |
| **May or July** | | | | | | | | | | |
| 6am, 6pm | 107.5 | 66 | 0.4018 | 43.2 | 72 | 0.3135 | 33.7 | 80 | 0.174 | 18.7 |
| 7am, 5pm | 207.2 | 66 | 0.4040 | 83.7 | 75 | 0.2616 | 54.2 | 68 | 0.375 | 77.7 |
| 8am, 4pm | 252.2 | 69 | 0.3607 | 91.0 | 80 | 0.1657 | 41.8 | 54 | 0.588 | 148.0 |
| 9am, 3pm | 273.4 | 73 | 0.2881 | 78.8 | 87 | 0.0590 | 16.1 | 42 | 0.743 | 203.0 |
| 10am, 2pm | 285.5 | 80 | 0.1708 | 48.8 | * | * | * | 29 | 0.875 | 249.7 |
| 11am, 1pm | 291.3 | 88 | 0.0288 | 8.4 | * | * | * | 17 | 0.956 | 278.4 |
| 12 noon | 293.0 | * | * | * | * | * | * | 10 | 0.985 | 288.5 |
| **June** | | | | | | | | | | |
| 6am, 6pm | 149.9 | 70 | 0.3396 | 50.9 | 76 | 0.2441 | 36.6 | 77 | 0.225 | 33.8 |
| 7am, 5pm | 237.9 | 71 | 0.3297 | 78.4 | 81 | 0.1575 | 37.5 | 59 | 0.515 | 122.6 |
| 8am, 4pm | 254.6 | 72 | 0.3086 | 78.6 | 83 | 0.1153 | 29.4 | 53 | 0.602 | 153.1 |
| 9am, 3pm | 276.9 | 77 | 0.2213 | 61.3 | * | * | * | 39 | 0.777 | 215.2 |
| 10am, 2pm | 286.7 | 83 | 0.1151 | 33.0 | * | * | * | 27 | 0.891 | 255.2 |
| 11am, 1pm | 292.2 | * | * | * | * | * | * | 14 | 0.970 | 283.5 |
| 12 noon | 293.1 | * | * | * | * | * | * | 6 | 0.995 | 291.5 |

*At these times the solar altitude is too high to permit irradiation of the wall.

Note: In cases where the southwest irradiation time scale ends at, or shortly after, noon, values of i, cos i, and $I_o$ cos i can be read at the time as given for a southwest facing wall.

the latent heat of vaporization.

*Solution*: From the last column of Table 9c, the maximum rate of irradiation of a horizontal surface occurs at 12 noon in June, at which time the rate is 291.5 Btu per sq ft per hr. Approximating the latent heat of vaporization as 1000 Btu per lb, the evaporation rate, subject to the indicated assumptions, would be 0.292 lb per hr per sq ft, or 5840 lb per hr for the 20,000 sq ft pond. Taking the weight of water as 8.345 lb per gal, this is a rate of 11.6 gpm.

**Example 3:**

Compare the total clear-day irradiation received per unit area by a 30 degree forward-sloping wall at latitude 30 degrees during June and during January, if the wall faces southwest.

*Solution*: In June, this wall is directly irradiated (Table 9c, column 9) only at four, five, and six o'clock in the afternoon. Total irradiation equals 36.6 + 37.5 + 29.4 = 103.5 Btu per sq ft. In

**Southeast or Southwest Wall** — **TABLE 10c** — **Latitude 35°**

| Solar Time | | 15° Slope forward | | | 30° Slope forward | | | Horizontal | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Southeast Southwest | $I_o$ | i | cos i | $I_o$ cos i | i | cos i | $I_o$ cos i | i | cos i | $I_o$ cos i |
| December | | | | | | | | | | |
| 8am, 4pm | 179.0 | 26 | 0.8954 | 160.3 | 41 | 0.7553 | 135.2 | 80 | 0.174 | 31.1 |
| 9am, 3pm | 239.0 | 32 | 0.8492 | 203.0 | 47 | 0.6822 | 163.0 | 73 | 0.292 | 69.9 |
| 10am, 2pm | 267.0 | 41 | 0.7510 | 200.5 | 56 | 0.5642 | 150.6 | 66 | 0.407 | 108.6 |
| 11am, 1pm | 279.0 | 52 | 0.6136 | 171.2 | 65 | 0.4200 | 117.2 | 61 | 0.485 | 135.2 |
| 12 noon | 287.6 | 64 | 0.4423 | 127.2 | 75 | 0.2543 | 73.1 | 58 | 0.530 | 152.4 |
| 1pm, 11am | 279.0 | 73 | 0.2842 | 79.3 | 83 | 0.1248 | 34.8 | 61 | 0.485 | 135.2 |
| 2pm, 10am | 267.0 | 84 | 0.1082 | 28.9 | * | * | * | 66 | 0.407 | 108.6 |
| Jan. or Nov. | | | | | | | | | | |
| 8am, 4pm | 196.0 | 28 | 0.8813 | 172.7 | 42 | 0.7389 | 144.8 | 79 | 0.191 | 37.4 |
| 9am, 3pm | 268.0 | 36 | 0.8067 | 216.2 | 51 | 0.6267 | 168.0 | 69 | 0.358 | 96.1 |
| 10am, 2pm | 287.0 | 45 | 0.7096 | 203.7 | 59 | 0.5101 | 146.4 | 62 | 0.470 | 134.8 |
| 11am, 1pm | 294.0 | 54 | 0.5862 | 172.3 | 67 | 0.3834 | 112.7 | 58 | 0.530 | 155.9 |
| 12 noon | 300.0 | 66 | 0.4111 | 123.3 | 78 | 0.2147 | 64.4 | 55 | 0.574 | 172.0 |
| 1pm, 11am | 294.0 | 76 | 0.2475 | 72.8 | 85 | 0.0797 | 23.4 | 58 | 0.530 | 155.9 |
| 2pm, 10am | 287.0 | 86 | 0.0704 | 20.2 | * | * | * | 62 | 0.470 | 134.8 |
| Feb. or Oct. | | | | | | | | | | |
| 7am, 5pm | 210.0 | 35 | 0.8166 | 171.5 | 46 | 0.6944 | 145.8 | 82 | 0.139 | 29.2 |
| 8am, 4pm | 245.0 | 36 | 0.8080 | 198.0 | 50 | 0.6457 | 158.2 | 73 | 0.292 | 71.7 |
| 9am, 3pm | 282.0 | 43 | 0.7369 | 207.8 | 57 | 0.5391 | 152.0 | 63 | 0.454 | 128.0 |
| 10am, 2pm | 297.0 | 52 | 0.6221 | 184.8 | 66 | 0.4000 | 118.8 | 54 | 0.588 | 174.5 |
| 11am, 1pm | 303.0 | 61 | 0.4910 | 148.8 | 75 | 0.2642 | 80.1 | 49 | 0.656 | 198.8 |
| 12 noon | 308.9 | 73 | 0.3001 | 92.7 | 85 | 0.0794 | 24.5 | 45 | 0.707 | 218.2 |
| 1pm, 11am | 303.0 | 82 | 0.1384 | 41.9 | * | * | * | 49 | 0.656 | 198.8 |
| Mar. or Sept. | | | | | | | | | | |
| 7am, 5pm | 157.0 | 47 | 0.6861 | 107.7 | 57 | 0.5501 | 86.4 | 76 | 0.242 | 38.0 |
| 8am, 4pm | 223.0 | 49 | 0.6602 | 147.2 | 62 | 0.4742 | 105.7 | 64 | 0.438 | 97.8 |
| 9am, 3pm | 258.9 | 52 | 0.6159 | 159.5 | 67 | 0.3985 | 103.2 | 55 | 0.574 | 148.4 |
| 10am, 2pm | 273.4 | 63 | 0.4534 | 124.0 | 78 | 0.2079 | 56.8 | 42 | 0.743 | 203.2 |
| 11am, 1pm | 280.8 | 72 | 0.3087 | 86.7 | 87 | 0.0572 | 16.1 | 35 | 0.819 | 230.0 |
| 12 noon | 283.5 | 82 | 0.1425 | 40.4 | * | * | * | 32 | 0.848 | 240.3 |
| Apr. or Aug. | | | | | | | | | | |
| 6am, 6pm | 83.5 | 59 | 0.5128 | 42.8 | 65 | 0.4222 | 35.3 | 82 | 0.139 | 11.6 |
| 7am, 5pm | 189.8 | 56 | 0.5618 | 106.6 | 65 | 0.4161 | 79.0 | 71 | 0.326 | 61.8 |
| 8am, 4pm | 241.0 | 59 | 0.5173 | 124.7 | 71 | 0.3214 | 77.5 | 58 | 0.530 | 127.7 |
| 9am, 3pm | 267.7 | 64 | 0.4396 | 117.7 | 78 | 0.2077 | 55.6 | 46 | 0.695 | 186.1 |
| 10am, 2pm | 281.6 | 72 | 0.3119 | 87.8 | 87 | 0.0572 | 16.1 | 34 | 0.829 | 233.4 |
| 11am, 1pm | 287.2 | 79 | 0.1832 | 52.6 | * | * | * | 26 | 0.899 | 258.0 |
| 12 noon | 289.1 | 89 | 0.0159 | 4.6 | * | * | * | 22 | 0.927 | 268.0 |
| May or July | | | | | | | | | | |
| 6am, 6pm | 133.5 | 67 | 0.3898 | 52.0 | 73 | 0.2935 | 39.2 | 78 | 0.208 | 27.8 |
| 7am, 5pm | 211.6 | 65 | 0.4217 | 89.2 | 74 | 0.2731 | 57.8 | 67 | 0.391 | 82.7 |
| 8am, 4pm | 252.2 | 67 | 0.3909 | 98.6 | 79 | 0.1927 | 48.6 | 54 | 0.588 | 148.2 |
| 9am, 3pm | 274.6 | 71 | 0.3175 | 87.2 | 85 | 0.0823 | 22.6 | 41 | 0.755 | 207.4 |
| 10am, 2pm | 284.8 | 77 | 0.2205 | 62.8 | * | * | * | 30 | 0.866 | 246.7 |
| 11am, 1pm | 290.2 | 85 | 0.0874 | 25.4 | * | * | * | 20 | 0.940 | 272.5 |
| 12 noon | 291.8 | * | * | * | * | * | * | 15 | 0.966 | 281.6 |
| June | | | | | | | | | | |
| 6am, 6pm | 157.0 | 70 | 0.3483 | 54.7 | 76 | 0.2474 | 38.8 | 76 | 0.242 | 38.0 |
| 7am, 5pm | 223.0 | 69 | 0.3595 | 80.2 | 78 | 0.2047 | 45.6 | 64 | 0.438 | 97.8 |
| 8am, 4pm | 256.7 | 70 | 0.3402 | 87.3 | 82 | 0.1398 | 35.9 | 52 | 0.616 | 158.0 |
| 9am, 3pm | 276.9 | 75 | 0.2647 | 73.3 | 88 | 0.0289 | 8.0 | 39 | 0.777 | 215.0 |
| 10am, 2pm | 286.7 | 81 | 0.1567 | 44.9 | * | * | * | 27 | 0.891 | 255.4 |
| 11am, 1pm | 291.3 | 88 | 0.0334 | 9.7 | * | * | * | 17 | 0.956 | 278.5 |
| 12 noon | 292.5 | * | * | * | * | * | * | 12 | 0.978 | 286.0 |

*At these times the solar altitude is too high to permit irradiation of the wall.

Note: In cases where the southeast irradiation time scale ends at, or shortly after, noon, values of i, cos i, and $I_o$ cos i can be read at the time as given for a southwest facing wall.

January, irradiation occurs from 12 noon until sundown and equals a total of 45.5 + 91.2 + 133.2 + 162.8 + 155.3 + 62.0 = 650 Btu per sq ft.

### Example 4:

A southeast-facing, vertical window has an area of 35 sq ft and is located in a building at latitude 30 degrees. The window is 8 ft high and extends to the ceiling from which a 6 ft horizontal overhang projects, thus providing partial shading. Determine the rate of irradiation of this window at 9 a.m. in February.

*Solution*: The 8 ft vertical window and the 6 ft horizontal overhang constitute two legs of a 3:4:5 right triangle having a hypotenuse of 10 ft. All of the solar energy striking a forward-inclined plane through the hypotenuse will also strike the window. Hence for purposes of analysis the vertical

**Southeast or Southwest Wall** — **TABLE 11c** — **Latitude 40°**

| Solar Time | | 15° Slope forward | | | 30° Slope forward | | | Horizontal | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Southeast Southwest | $I_o$ | i | cos i | $I_o$ cos i | i | cos i | $I_o$ cos i | i | cos i | $I_o$ cos i |
| **December** | | | | | | | | | | |
| 8am, 4pm | 168.0 | 26 | 0.9022 | 151.6 | 40 | 0.7660 | 128.7 | 81 | 0.156 | 26.3 |
| 9am, 3pm | 223.0 | 29 | 0.8729 | 194.7 | 44 | 0.7177 | 160.0 | 76 | 0.242 | 54.0 |
| 10am, 2pm | 261.0 | 38 | 0.7842 | 204.7 | 52 | 0.6111 | 159.5 | 70 | 0.342 | 89.2 |
| 11am, 1pm | 274.0 | 49 | 0.6592 | 180.6 | 61 | 0.4816 | 132.0 | 66 | 0.407 | 111.5 |
| 12 noon | 276.8 | 59 | 0.5098 | 141.1 | 70 | 0.3437 | 95.1 | 65 | 0.423 | 117.0 |
| 1pm, 11am | 274.0 | 70 | 0.3361 | 92.1 | 79 | 0.1921 | 52.6 | 66 | 0.407 | 111.5 |
| 2pm, 10am | 261.0 | 81 | 0.1618 | 42.2 | 87 | 0.0532 | 13.9 | 70 | 0.342 | 89.2 |
| **Jan. or Nov.** | | | | | | | | | | |
| 8am, 4pm | 170.0 | 26 | 0.8959 | 152.3 | 40 | 0.7614 | 129.4 | 81 | 0.156 | 26.6 |
| 9am, 3pm | 240.0 | 31 | 0.8569 | 205.7 | 46 | 0.6940 | 166.6 | 74 | 0.276 | 66.2 |
| 10am, 2pm | 277.0 | 41 | 0.7510 | 208.0 | 56 | 0.5642 | 156.3 | 66 | 0.407 | 112.7 |
| 11am, 1pm | 287.0 | 51 | 0.6318 | 181.3 | 64 | 0.4404 | 126.4 | 62 | 0.470 | 134.9 |
| 12 noon | 288.0 | 62 | 0.4721 | 136.0 | 73 | 0.2931 | 84.4 | 61 | 0.485 | 139.7 |
| 1pm, 11am | 287.0 | 74 | 0.2790 | 80.1 | 83 | 0.1243 | 35.7 | 62 | 0.470 | 134.9 |
| 2pm, 10am | 277.0 | 84 | 0.1082 | 30.0 | * | * | * | 66 | 0.407 | 112.7 |
| **Feb. or Oct.** | | | | | | | | | | |
| 7am, 5pm | 152.0 | 35 | 0.8166 | 124.1 | 46 | 0.6944 | 105.5 | 82 | 0.139 | 21.2 |
| 8am, 4pm | 232.0 | 34 | 0.8254 | 191.5 | 48 | 0.6702 | 155.5 | 75 | 0.259 | 60.0 |
| 9am, 3pm | 274.0 | 39 | 0.7752 | 212.4 | 54 | 0.5858 | 160.5 | 66 | 0.407 | 111.5 |
| 10am, 2pm | 291.0 | 48 | 0.6693 | 194.8 | 63 | 0.4582 | 133.3 | 58 | 0.530 | 154.1 |
| 11am, 1pm | 298.0 | 58 | 0.5318 | 158.5 | 72 | 0.3153 | 94.0 | 53 | 0.602 | 179.5 |
| 12 noon | 304.5 | 68 | 0.3681 | 112.1 | 81 | 0.1611 | 49.1 | 51 | 0.629 | 191.7 |
| 1am, 11am | 298.0 | 79 | 0.1945 | 58.0 | 89 | 0.0130 | 3.9 | 53 | 0.602 | 179.5 |
| **Mar. or Sept.** | | | | | | | | | | |
| 7am, 5pm | 133.5 | 46 | 0.7008 | 93.6 | 55 | 0.5723 | 76.4 | 78 | 0.208 | 27.8 |
| 8am, 4pm | 215.6 | 46 | 0.6948 | 149.8 | 59 | 0.5135 | 110.7 | 66 | 0.407 | 87.8 |
| 9am, 3pm | 247.0 | 50 | 0.6390 | 157.8 | 65 | 0.4223 | 104.3 | 56 | 0.559 | 138.1 |
| 10am, 2pm | 264.5 | 57 | 0.5435 | 143.8 | 72 | 0.3083 | 81.5 | 48 | 0.669 | 177.0 |
| 11am, 1pm | 274.6 | 67 | 0.3923 | 107.7 | 81 | 0.1494 | 41.0 | 41 | 0.755 | 207.4 |
| 12 noon | 277.0 | 77 | 0.2288 | 63.4 | * | * | * | 39 | 0.777 | 215.2 |
| 1pm, 11am | 274.6 | 88 | 0.0421 | 11.6 | * | * | * | 41 | 0.755 | 207.4 |
| **Apr. or Aug.** | | | | | | | | | | |
| 6am, 6pm | 98.0 | 59 | 0.5205 | 51.0 | 65 | 0.4243 | 41.6 | 81 | 0.156 | 15.3 |
| 7am, 5pm | 196.3 | 56 | 0.5646 | 110.8 | 66 | 0.4142 | 81.3 | 70 | 0.342 | 67.1 |
| 8am, 4pm | 237.9 | 56 | 0.5532 | 131.6 | 69 | 0.3577 | 85.1 | 59 | 0.515 | 122.5 |
| 9am, 3pm | 264.4 | 61 | 0.4877 | 128.9 | 75 | 0.2578 | 68.2 | 48 | 0.669 | 177.0 |
| 10am, 2pm | 278.9 | 67 | 0.3863 | 107.7 | 82 | 0.1351 | 37.7 | 38 | 0.788 | 220.0 |
| 11am, 1pm | 284.1 | 75 | 0.2540 | 72.2 | * | * | * | 31 | 0.857 | 243.5 |
| 12 noon | 286.8 | 85 | 0.0795 | 22.8 | * | * | * | 27 | 0.891 | 255.7 |
| **May or July** | | | | | | | | | | |
| 6am, 6pm | 149.9 | 67 | 0.3982 | 59.7 | 73 | 0.2965 | 44.4 | 77 | 0.225 | 33.8 |
| 7am, 5pm | 211.6 | 63 | 0.4465 | 94.5 | 73 | 0.2953 | 62.5 | 67 | 0.391 | 82.7 |
| 8am, 4pm | 249.8 | 64 | 0.4397 | 109.8 | 76 | 0.2404 | 60.1 | 55 | 0.574 | 143.3 |
| 9am, 3pm | 272.1 | 68 | 0.3755 | 102.2 | 82 | 0.1405 | 38.2 | 43 | 0.731 | 199.0 |
| 10am, 2pm | 282.5 | 73 | 0.2887 | 81.6 | 88 | 0.0340 | 9.6 | 33 | 0.839 | 237.0 |
| 11am, 1pm | 288.3 | 81 | 0.1528 | 44.1 | * | * | * | 24 | 0.914 | 263.5 |
| 12 noon | 290.2 | * | * | * | * | * | * | 20 | 0.940 | 272.5 |
| **June** | | | | | | | | | | |
| 6am, 6pm | 165.2 | 69 | 0.3566 | 58.9 | 76 | 0.2502 | 41.3 | 75 | 0.259 | 42.8 |
| 7am, 5pm | 226.5 | 65 | 0.3885 | 88.0 | 77 | 0.2265 | 51.3 | 63 | 0.454 | 102.8 |
| 8am, 4pm | 256.7 | 68 | 0.3789 | 97.3 | 80 | 0.1747 | 44.8 | 52 | 0.616 | 158.0 |
| 9am, 3pm | 275.8 | 72 | 0.3105 | 85.6 | 86 | 0.0730 | 20.1 | 40 | 0.766 | 211.2 |
| 10am, 2pm | 285.5 | 78 | 0.2137 | 61.0 | * | * | * | 29 | 0.875 | 250.0 |
| 11am, 1pm | 289.8 | 84 | 0.1038 | 30.1 | * | * | * | 21 | 0.934 | 271.0 |
| 12 noon | 290.8 | * | * | * | * | * | * | 16 | 0.961 | 279.3 |

*At these times the solar altitude is too high to permit irradiation of the wall.

Note: In cases where the southeast irradiation time scale ends at, or shortly after, noon, values of i, cos i, and $I_o$ cos i can be read at the time as given for a southwest facing wall.

window can be replaced by the 30 degree forward-inclined plane with an area of (10/8) 35 or 43.8 sq ft.

From column 9 of Table 9c, $I_o$ cos $i$ is equal to 145.1 at 9 a.m. in February, so total irradiation of the plane (and therefore of the window) amounts to (145.1) (43.8) = 6355 Btu per hr.

The method of solution used for this example is applicable to all vertical windows which are partially protected from direct radiation by means of overhang. In such cases, the angle of the forward-sloping plane through the hypotenuse should be calculated and the irradiation rate on this plane then determined from the tables by interpolation among values for 15 degree, 30 degree, or vertical walls.

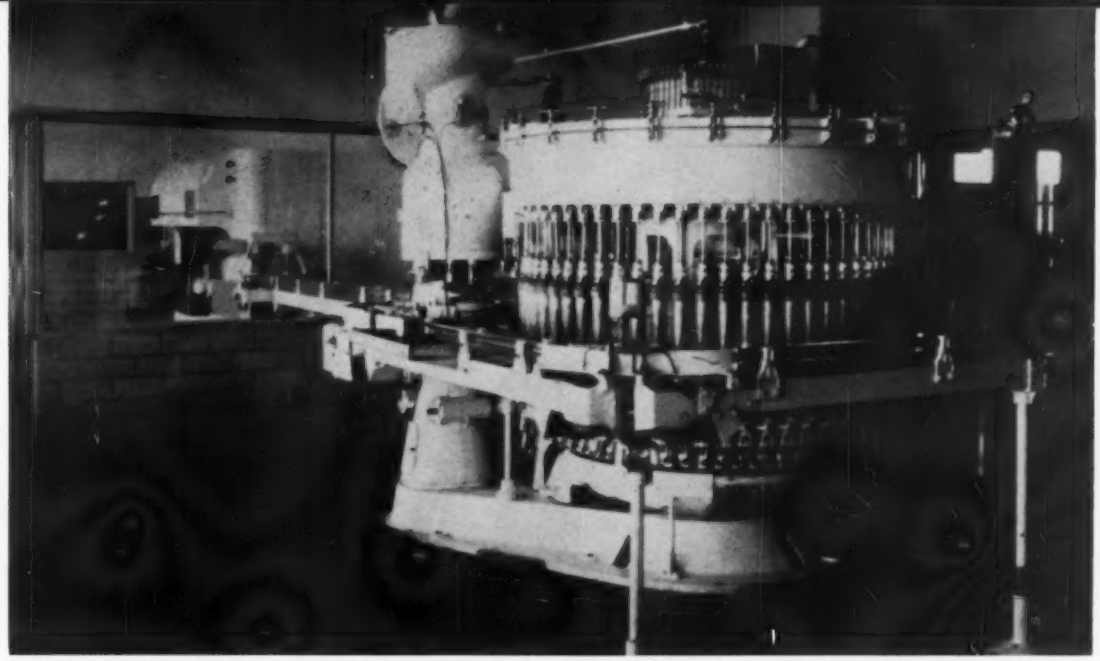
Cosines in the tables have been calculated to four decimal places, but corresponding angles are given to the nearest degree. ⌗

**Southeast or Southwest Wall** — **TABLE 12c** — **Latitude 45°**

| Solar Time | | 15° Slope forward | | | 30° Slope forward | | | Horizontal | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Southeast Southwest | $I_o$ | i | cos i | $I_o$ cos i | i | cos i | $I_o$ cos i | i | cos i | $I_o$ cos i |
| **December** | | | | | | | | | | |
| 8am, 4pm | 168.0 | 25 | 0.9045 | 152.0 | 40 | 0.7685 | 129.1 | 81 | 0.156 | 16.3 |
| 9am, 3pm | 194.0 | 26 | 0.8962 | 173.9 | 41 | 0.7527 | 146.0 | 79 | 0.191 | 37.0 |
| 10am, 2pm | 215.0 | 33 | 0.8421 | 181.1 | 46 | 0.6942 | 149.3 | 77 | 0.225 | 48.4 |
| 11am, 1pm | 251.0 | 44 | 0.7156 | 179.6 | 56 | 0.5586 | 140.2 | 72 | 0.309 | 77.6 |
| 12 noon | 260.0 | 57 | 0.5450 | 141.7 | 67 | 0.3924 | 102.0 | 69 | 0.358 | 93.3 |
| 1pm, 11am | 251.0 | 68 | 0.3795 | 95.3 | 75 | 0.2572 | 64.6 | 72 | 0.309 | 77.6 |
| 2pm, 10am | 215.0 | 77 | 0.2170 | 46.7 | 82 | 0.1342 | 28.9 | 77 | 0.225 | 48.4 |
| 3pm, 9am | 194.0 | 89 | 0.0167 | 3.2 | * | * | * | 79 | 0.191 | 37.0 |
| **Jan. or Nov.** | | | | | | | | | | |
| 8am, 4pm | 154.0 | 25 | 0.9061 | 139.5 | 39 | 0.7745 | 119.3 | 82 | 0.139 | 21.4 |
| 9am, 3pm | 218.0 | 28 | 0.8848 | 192.9 | 43 | 0.7304 | 159.2 | 77 | 0.225 | 49.1 |
| 10am, 2pm | 248.0 | 35 | 0.8168 | 202.6 | 49 | 0.6539 | 162.2 | 73 | 0.292 | 72.6 |
| 11am, 1pm | 271.0 | 47 | 0.6865 | 186.0 | 59 | 0.5149 | 139.5 | 68 | 0.375 | 101.5 |
| 12 noon | 280.0 | 59 | 0.5098 | 142.7 | 70 | 0.3437 | 96.2 | 65 | 0.423 | 118.4 |
| 1pm, 11am | 271.0 | 70 | 0.3374 | 91.4 | 78 | 0.2019 | 54.7 | 68 | 0.375 | 101.5 |
| 2pm, 10am | 248.0 | 81 | 0.1635 | 40.5 | 86 | 0.0682 | 16.9 | 73 | 0.292 | 72.6 |
| **Feb. or Oct.** | | | | | | | | | | |
| 8am, 4pm | 215.0 | 32 | 0.8469 | 182.1 | 46 | 0.6983 | 150.1 | 77 | 0.225 | 48.4 |
| 9am, 3pm | 268.0 | 37 | 0.7976 | 213.8 | 52 | 0.6144 | 164.7 | 68 | 0.375 | 100.5 |
| 10am, 2pm | 282.0 | 43 | 0.7273 | 205.1 | 58 | 0.5301 | 149.5 | 63 | 0.454 | 128.2 |
| 11am, 1pm | 291.0 | 54 | 0.5862 | 170.6 | 67 | 0.3834 | 111.6 | 58 | 0.530 | 154.2 |
| 12 noon | 296.7 | 66 | 0.4111 | 122.0 | 78 | 0.2147 | 63.7 | 55 | 0.574 | 170.0 |
| 1pm, 11am | 291.0 | 76 | 0.2475 | 72.0 | 85 | 0.0798 | 23.2 | 58 | 0.530 | 154.2 |
| 2pm, 10am | 282.0 | 87 | 0.0467 | 13.2 | * | * | * | 63 | 0.454 | 128.2 |
| **Mar. or Sept.** | | | | | | | | | | |
| 7am, 5pm | 117.0 | 43 | 0.7369 | 86.2 | 52 | 0.6093 | 71.3 | 79 | 0.191 | 22.3 |
| 8am, 4pm | 207.2 | 44 | 0.7214 | 149.5 | 57 | 0.5461 | 113.2 | 68 | 0.375 | 77.7 |
| 9am, 3pm | 237.9 | 47 | 0.6797 | 161.7 | 62 | 0.4710 | 112.1 | 59 | 0.515 | 122.5 |
| 10am, 2pm | 258.9 | 54 | 0.5848 | 151.4 | 69 | 0.3554 | 92.0 | 51 | 0.629 | 162.8 |
| 11am, 1pm | 267.7 | 63 | 0.4502 | 120.5 | 77 | 0.2171 | 58.1 | 46 | 0.695 | 186.2 |
| 12 noon | 270.6 | 73 | 0.2884 | 78.0 | 86 | 0.0657 | 17.8 | 44 | 0.719 | 194.8 |
| 1pm, 11am | 267.7 | 83 | 0.1139 | 30.5 | * | * | * | 46 | 0.695 | 186.2 |
| **Apr. or Aug.** | | | | | | | | | | |
| 6am, 6pm | 98.0 | 58 | 0.5338 | 52.3 | 64 | 0.4364 | 42.8 | 81 | 0.156 | 15.3 |
| 7am, 5pm | 196.3 | 54 | 0.5863 | 115.1 | 64 | 0.4336 | 85.1 | 70 | 0.342 | 67.2 |
| 8am, 4pm | 235.1 | 55 | 0.5801 | 136.4 | 67 | 0.3858 | 90.7 | 60 | 0.500 | 117.5 |
| 9am, 3pm | 260.4 | 57 | 0.5374 | 139.9 | 72 | 0.3093 | 80.5 | 50 | 0.643 | 167.5 |
| 10am, 2pm | 274.6 | 64 | 0.4389 | 120.5 | 79 | 0.1906 | 52.3 | 41 | 0.755 | 207.3 |
| 11am, 1pm | 280.8 | 72 | 0.3119 | 87.6 | 87 | 0.0600 | 16.8 | 35 | 0.819 | 230.0 |
| 12 noon | 283.5 | 82 | 0.1426 | 40.4 | * | * | * | 32 | 0.848 | 240.5 |
| **May or July** | | | | | | | | | | |
| 6am, 6pm | 157.0 | 65 | 0.4201 | 66.0 | 72 | 0.3118 | 49.0 | 76 | 0.242 | 38.0 |
| 7am, 5pm | 219.6 | 62 | 0.4651 | 102.1 | 72 | 0.3036 | 66.7 | 65 | 0.423 | 92.9 |
| 8am, 4pm | 249.8 | 62 | 0.4666 | 116.6 | 75 | 0.2644 | 66.0 | 55 | 0.574 | 143.2 |
| 9am, 3pm | 269.3 | 64 | 0.4310 | 116.1 | 79 | 0.1967 | 53.0 | 45 | 0.707 | 190.7 |
| 10am, 2pm | 280.8 | 70 | 0.3339 | 93.8 | 85 | 0.0796 | 22.4 | 35 | 0.819 | 230.0 |
| 11am, 1pm | 286.1 | 78 | 0.2117 | 60.6 | * | * | * | 28 | 0.883 | 252.5 |
| 12 noon | 287.8 | 87 | 0.0541 | 15.6 | * | * | * | 25 | 0.906 | 261.0 |
| **June** | | | | | | | | | | |
| 6am, 6pm | 172.1 | 69 | 0.3647 | 62.8 | 75 | 0.2529 | 43.5 | 74 | 0.276 | 47.5 |
| 7am, 5pm | 226.5 | 66 | 0.4125 | 93.4 | 76 | 0.2480 | 56.2 | 63 | 0.454 | 102.8 |
| 8am, 4pm | 256.7 | 65 | 0.4154 | 106.6 | 78 | 0.2072 | 53.2 | 52 | 0.616 | 158.1 |
| 9am, 3pm | 273.4 | 68 | 0.3731 | 102.0 | 82 | 0.1351 | 36.9 | 42 | 0.743 | 203.5 |
| 10am, 2pm | 283.3 | 74 | 0.2793 | 79.1 | 89 | 0.0231 | 6.5 | 32 | 0.848 | 240.3 |
| 11am, 1pm | 287.8 | 80 | 0.1662 | 47.8 | * | * | * | 25 | 0.906 | 261.5 |
| 12 noon | 289.9 | 90 | 0.0032 | 0.9 | * | * | * | 21 | 0.934 | 271.5 |

***At these times the solar altitude is too high to permit irradiation of the wall.**

**Note: In cases where the southeast irradiation time scale ends at, or shortly after, noon, values of i, cos i, and $I_o$ cos i can be read at the time as given for a southwest facing wall.**



1 FIRST ARRANGEMENT for bottling line places washer in room separate from filling operation. Washer room may be air conditioned, but bottles pass through dusty air before filling

# Bottling Plants Can Be Air Conditioned

**● The spotless equipment and spaces of many modern soft drink bottling works may be deceiving, says the author. Behind the glass front of the washing area, the air may be hot and humid, and extremely dusty besides. Proper filtering and cooling can make the whole operation as sanitary as it appears. This can be accomplished in spite of the heat-producing washing machines that many operators consider a permanent deterrent to air conditioning. It has in fact been accomplished in several soft drink franchise bottling plants throughout the country.**

**Mr. Shaw has been a practicing architect, and since World War II has designed some 300 bottling plants. He is secretary-treasurer of the Standardization Committee of Bottlers of Coca-Cola.**

By JOHN SHAW
Plant Design Department
The Coca-Cola Co.
Atlanta, Ga.

THE HEART of a soft drink production plant is its machinery area — it is nearly always the part of the plant that costs the most, where frequently a quarter of a million dollars worth of machinery may be housed; and the part that the bottling plant owner must show first to his visitors.

Machinery manufacturers have often gone far beyond the mere requirements of quality to make a machine with aesthetic lines as well as functional use. Architects frequently designate the room for public display, fronting the area with glass and using various colors to set off the stainless steel and white-painted machinery.

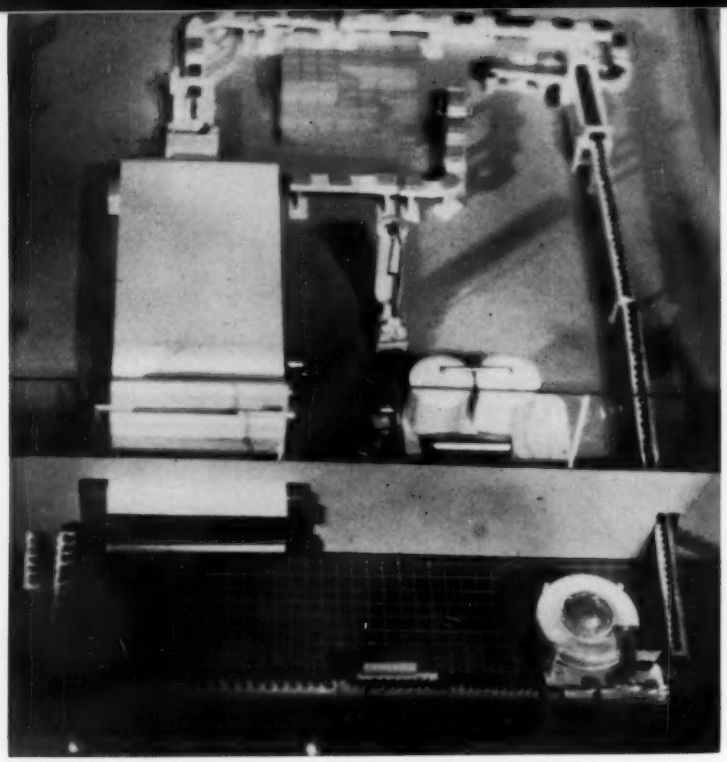
Nor is this attention purely for the benefit of tours. The necessity for faultless quality control is now an accepted part of most bottlers' programs, and is in varying degrees a part of the by-laws and codes of many authorities.

## Inside — Another Story

I have indicated the desirability, even necessity, for making this bottling room a showplace. Imagine the visitor's surprise on entering the room. A steamy, over-warm atmosphere prevails, employee discomfort is high, tempers are short. Maybe worst of all, public reaction is poor. The room is spotless but the air is anything but matching.

In other words, everything is clean except the air through which the empty and uncovered bottles must pass before being filled. The air is dust laden, and certainly not a type of environment in which to conduct a careful quality process.

How much dust is in the air? We talked to Dr. Lewis McCabe, a member of the National Advisory Committee on Atmospheric Pollution. He stated that a dirt fallout of 50 tons per sq mile per month is not uncommon in large cities. Washington, D.C. has had a rate of 34 tons per month, and at least one city had a fallout of more than 200 tons per sq mile per month.



**2** SLIGHT PROJECTION of washer into filling room causes production layout problems

Even fairly small urban areas don't necessarily escape. Here 15 to 20 tons per sq mile per month would be fairly representative figures.

Predictions for the future are for an increase in dirt incidence.

### Dirt Is Filterable

Practically all these outside air pollutants are filterable by means of either disposable or electrostatic air cleaners, some of which may be 95 percent efficient.

In the summertime, however, the "average" bottling room requires 35 to 40 air changes per hr, and to thoroughly clean this considerable volume might require an investment in equipment greater than can be made.

Some means must then be found to reduce the volume of incoming air. This can be done by cooling, to the extent that the number of air changes might be reduced to 8 or 10.

These figures represent an average condition necessary to maintain desireable comfort standards for the workers in the bottling area, in the presence of a large size bottle washer. This machine, of course, is the center of washing operation and produces a considerable quantity of heat.

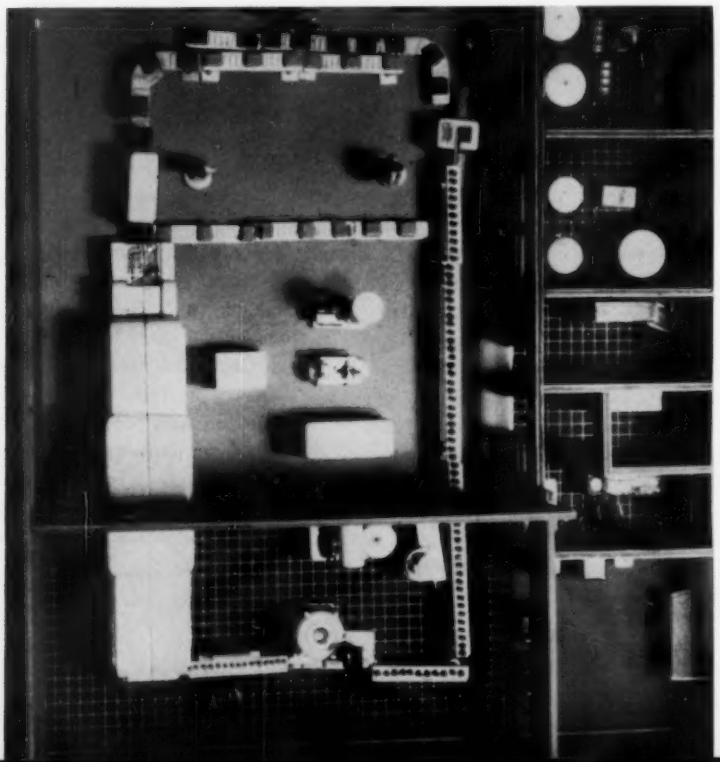
### Try Varied Arrangements

There are four different basic layouts for the operation that have been tried in conjunction with air conditioning of the room.

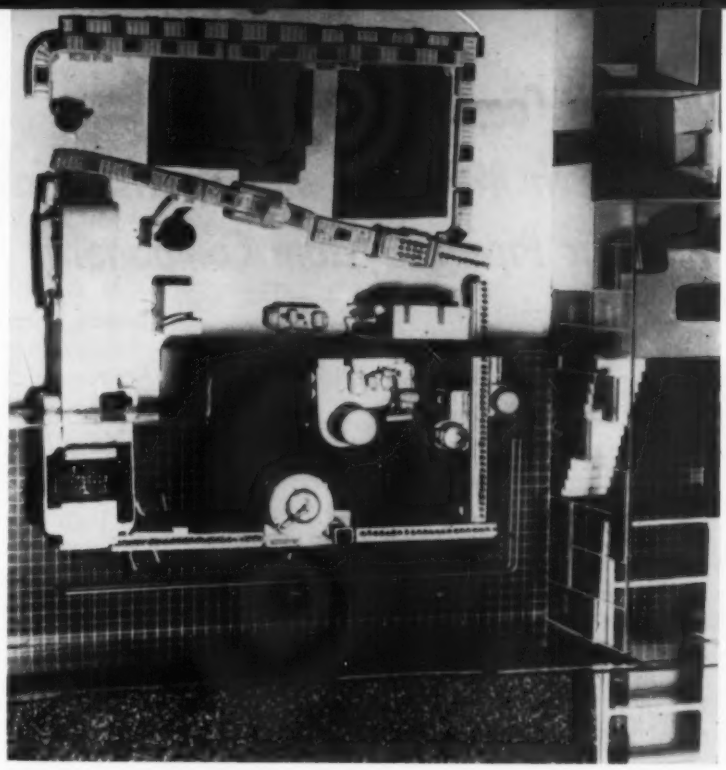
First, washers have been located in separate rooms from the filling machine (Fig. 1). This can produce production flow problems, and besides, the washed empty bottles will be discharged from the bottle washer into dust laden air prior to filling.

A second method is to place the washer in a seperate room, but projecting a few in. through the dividing wall. However, in many plants with limited area the additional depth required for the production machinery is a practical disadvantage (Fig. 2). This layout also requires several bends in the empty bottle line.

By moving the washer half in and half out of the filling room, (Fig. 3), the number of bends between washer discharge and filling machine are reduced, but a portion of the hot area of the washer projects into the filling space.



**3** HALF AND HALF arrangement leaves portion of hot washer surface in filling room



**4** DOG LEG plan may work well for relatively low speed lines

The fourth method cures this by moving the washer slightly back and enclosing all but the discharge end with a dog-leg type of partition. This may be the best solution where the production line is of a relatively low speed. For high speed lines, the arrangement shown in Fig. 2 may be the best answer.

### Good Cooling Is Possible

Many have said that it is impractical to air condition the room with a washer in it. To analyze the validity of this argument, tests were made of the surface temperatures of an operating washing machine.

These measurements were made along all surfaces of the washer and in addition, temperature measurements were made of the clean bottles as they emerged. Hp ratings for the electric motors were noted, and the amount of heat emission under load conditions calculated.

Fig. 5 shows the results of the tests. The series was based on certain specifics; to wit:

1) A recommended reasonable temperature, DB and WB

2) The washer used was completely sealed except for the discharge and load ends.

3) An assumed air velocity within the area of 50 fpm.

4) Tests were for this one washer only and employee latent heat load was not considered.

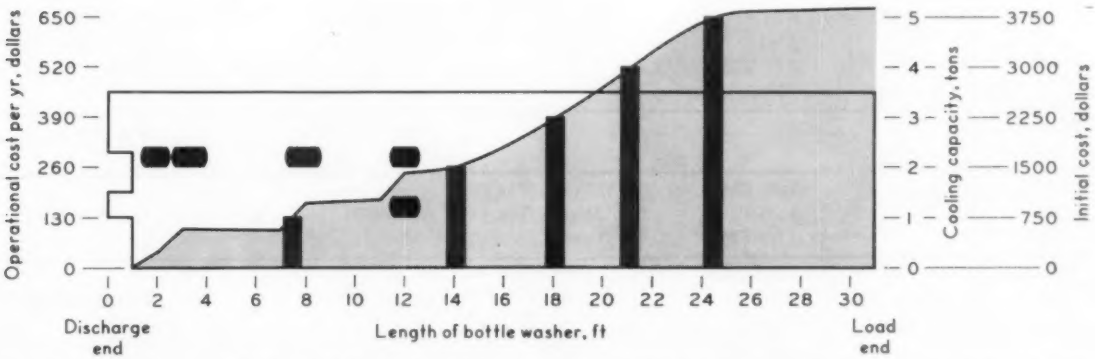
From the chart, it can be seen that if a separate bottling room is built with the partition located at a strategic point (about 12 ft from the discharge end) not more than 2 tons of cooling capacity will be required to dissipate the sensible heat from the unit.

The latent heat of the unit can be handled by relatively minor modifications to the machine itself, such as locks on lids, a stack for steam removal, and others, all of which have been successfully accomplished in existing plants.

Improved operation of electronic bottle inspection machines and other equipment in a dry atmosphere is well established. Air conditioning with its humidity control offers this.

The cost for all this is relatively slight. Investment will vary of course, depending upon the size of the room and the heat loads that can be excluded, but in many cases it has been as low as 01 percent of the total machinery cost for the plant.

Clearly then, air cooling and cleaning in a properly designed bottling room is quite within the realm of economic feasibility. ≠




**5** TEMPERATURE TESTS on bottle washing equipment, described in text and summarized in chart above, indicated feasibility of economic cooling installations in bottling plants

# Use This Comparison Chart To Match Materials and Specifications In Basic Piping System Components

By F. W. HOLMES
Director, Technical Services
Midwest Piping Division
Crane Co.

ENGINEERS concerned with the design, installation, and maintenance of piping systems are these days confronted with an ever-growing list of piping component specifications. To make sure that the various basic parts of a piping system are of the same or equivalent materials is becoming more and more difficult as the latitude for selection widens.

To ease this task of comparison and selection, Midwest Piping Division of Crane Co. has prepared the following piping component comparison chart (Table 1). In this chart are grouped, according to material, specifications for the various components of a welded piping system: pipe, tubing, welding fittings, and flanges, and in addition, specifications for welding rod that might be used to join the components*.

Note that strength and quality requirements within each group of specifications are not always comparable; therefore before deciding on a particular material, reference to the individual specification should be made.

Both the specification number and the grade of metal are shown; for example, ASTM Specification A-106, Grade B, is indicated in the table as A106-B.

In some cases, other specifications exist and may be required for special piping installations; however, those shown are in most frequent use today. ⧺

**Table 1 is adapted from the Piping Design Data section of Midwest Piping Division, Crane Co.'s catalog 61, a copy of which is available on request to the company at P.O. Box 433, St. Louis 66, Mo.*

**TABLE 1 — PIPING COMPONENTS are here grouped according to comparable material specifications. Within groups separated by lighter horizontal lines, any one specification can be used with any other specification in same group**

| Material | | Piping components | | | | |
|---|---|---|---|---|---|---|
| | | Pipe | Tubing | Welding fittings[2] | Flanges | Welding rod |
| Carbon steel | Grade A | A53-A<br>A106-A<br>A135-A<br>A139-A<br>A155-C50, C55<br>API-5L-A | A83-A<br>A161<br>A178-A<br>A179<br>A192<br>A226 | A234-WPA | A105-1, 11<br>A181-1, 11 | A233-E6010 |
| | Grade B | A53-B<br>A106-B<br>A135-B<br>A139-B<br>A155-KC65, KC70<br>API-5L-B | A178-C<br>A210 | A234-WPB | A105-1, 11<br>A181-1, 11 | A233-E6010 |
| | Grade C | A106-C | | A234-WPC | A105-1, 11<br>A181-1, 11 | A233-E6010 |
| | Low Temperature | A333-0 | A334-0 | A420-WPLO | A350-LF1 | A233-E6016 |
| | High Yield | A381<br>API-5LX-X42, X46, X52 | | Grade WPY42[2,3] to Grade WPY52[2,3] | A105-11 | A233-E6010<br>A316-E7010-A1 |
| Wrought iron | | A72 | | Grade WPWI[2] | A73 | A233-E6010 |
| Carbon moly steel | ½ Mo | A155-CM70<br>A335-P1<br>A369-FP1 | A209-T1, T1a, T1b<br>A250-T1, T1a, T1b | A234-WP1 | A182-F1 | A316-E7010-A1 |
| Chrome moly steel | ½ Cr-½ Mo | A155-½CR<br>A335-P2<br>A369-FP2 | | Grade WP2[2] | | A316-E8016-B1 |
| | 1 Cr-½ Mo | A155-1CR<br>A335-P12<br>A369-FP12 | A213-T12 | A234-WP12 | A182-F12 | A316-E8016-B2 |

*Continued on following page*

| | | Pipe | Tubing | Welding fittings[1] | Flanges | Welding rod |
|---|---|---|---|---|---|---|
| Chrome moly steel *(cont)* | 1¼ Cr-½ Mo | A155-1¼ CR<br>A335-P11<br>A369-FP11 | A200-T11<br>A213-T11 | A234-WP11 | A182-F11 | A316-E8016-B2 |
| | 2¼ Cr-1 Mo | A155-2¼ CR<br>A335-P22<br>A369-FP22 | A200-T22<br>A213-T22 | A234-WP22 | A182-F22 | A316-E9016-B3 |
| | 5 Cr-½ Mo | A155-5CR<br>A335-P5<br>A369-FP5 | A200-T5<br>A213-T5 | A234-WP5 | A182-F5 | A298-E502 |
| | 7 Cr-½ Mo | A335-P7<br>A369-FP7 | A200-T7<br>A213-T7 | Grade WP7[2] | A182-F7 | 505-15[4] |
| | 9 Cr-1 Mo | A335-P9<br>A369-FP9 | A200-T9<br>A213-T9 | Grade WP9[2] | A182-F9 | 505-15[4] |
| Low temperature ferritic steel | 3½ Ni | A333-3 | A334-3 | A420-WPL3 | A350-LF3 | A316-E8016-C1 |
| | Cr-Cu-Ni-Al Low alloy steel | A333-4 | | A420-WPL4 | A350-LF4 | (5) |
| | 5 Ni | A333-5 | A334-5 | A420-WPL5 | | (5) |
| Stainless austenitic steel | Type 304 18 Cr-8 Ni | A312-TP304<br>A358-304<br>A376-TP304 | A213-TP304<br>A249-TP304<br>A269-TP304<br>A271-TP304 | A403-WP304 | A182-F304 | A298-E308-15 |
| | | A312-TP304H<br>A376-TP304H | A213-TP304H<br>A249-TP304H<br>A271-TP304H | A403-WP304H | A182-F304H | A298-E308-15 |
| | | A312-TP304L | A213-TP304L<br>A249-TP304L<br>A269-TP304L | A403-WP304L | A182-F304L | A298-E308ELC-15 |
| | Type 309 25 Cr-12 Ni | A312-TP309<br>A358-309 | A249-TP309 | A403-WP309 | A314-309 | A298-E309-15 |
| | Type 310 25 Cr-20 Ni | A312-TP310<br>A358-310 | A213-TP310<br>A249-TP310 | A403-WP310 | A182-F310 | A298-E310-15 |
| | Type 316 16 Cr-13 Ni with 2½ Mo | A312-TP316<br>A358-316<br>A376-TP316 | A213-TP316<br>A249-TP316<br>A269-TP316 | A403-WP316 | A182-F316 | A298-E316-15 |
| | | A312-TP316H<br>A376-TP316H | A213-TP316H<br>A249-TP316H | A403-WP316H | A182-F316H | A298-E316-15 |
| | | A312-TP316L | A213-TP316L<br>A249-TP316L<br>A269-TP316L | A403-WP316L | A182-F316L | A298-E316ELC-15 |
| | Type 317 16 Cr-13 Ni with 3½ Mo | A312-TP317 | A249-TP317<br>A269-TP317 | A403-WP317 | A314-317 | A298-E317-15 |
| | Type 321 18 Cr-8 Ni with Ti | A312-TP321<br>A358-321<br>A376-TP321 | A213-TP321<br>A249-TP321<br>A269-TP321<br>A271-TP321 | A403-WP321 | A182-F321 | A298-E347-15 |
| | | A312-TP321H<br>A376-TP321H | A213-TP321H<br>A249-TP321H<br>A271-TP321H | A403-WP321H | A182-F321H | A298-E347-15 |
| | Type 347 18 Cr-8 Ni with Ta-Cb | A312-TP347<br>A358-347<br>A376-TP347 | A213-TP347<br>A249-TP347<br>A269-TP347<br>A271-TP347 | A403-WP347 | A182-F347 | A298-E347-15 |
| | | A312-TP347H<br>A376-TP347H | A213-TP347H<br>A249-TP347H<br>A271-TP347H | A403-WP347H | A182-F347H | A298-E347-15 |
| | Type 348 18 Cr-8 Ni with Cb | A312-TP348<br>A358-348<br>A376-TP348 | A213-TP348<br>A249-TP348<br>A269-TP348<br>A271-TP348 | A403-WP348 | A182-F348 | A298-E347-15 |
| | | A312-TP348H | A213-TP348H<br>A249-TP348H<br>A271-TP348H | A403-WP348H | A182-F348H | A298-E347-15 |

*Continued on following page*

TABLE 1 — *Continued*

| Material | | Pipe | Tubing | Welding fittings[1] | Flanges | Welding rod |
|---|---|---|---|---|---|---|
| Nickel and nickel base alloys | Nickel | B161 | | Grade WPN[2] | (6) | B295-E3N11 |
| | Nickel (low carbon) | B161 | | Grade WPNL[2] | (6) | B295-E4N11 |
| | Monel Ni-Cu | B165 | | Grade WPNC[2] | (6) | B295-E3N10 |
| | Inconel Ni-Cr-Fe | B167 | | Grade WPNI[2] | (6) | B295-E3N12 |
| | Hastelloy B Ni-Mo | (6) | | Grade WPHB[2] | (6) | B295-E3N1B |
| | Hastelloy C Ni-Mo-Cr | (6) | | Grade WPHC[2] | (6) | B295-E3N1C |
| Titanium | 99.3% Ti | B337-1 | B338-1 | Grade WPT1[2] | | |
| | 99.2% Ti | B337-2 | B338-2 | Grade WPT2[2] | (6) | Ti-40A[4] |
| | 99.0% Ti | B337-3 | B338-3 | Grade WPT3[2] | | |
| | 98.0% Ti | B337-4 | B338-4 | Grade WPT4[2] | | |
| Copper and copper base alloys | Pure copper | B42 | | Grade WPCU[2] | B124-12 | B225-ECu |
| | Red brass 85% Cu 15% Zn | B43 | | Grade WPRB[2] | B36-3 | B260-RCuZn |
| | Yellow brass 70% Cu 30% Zn | (6) | B135-2 | Grade WPYB[2] | B36-6 | B260-RCuZn |
| | Silicon bronze 95% Cu 3% Si | B315-A-7 | B315-A-7 | Grade WPSB[2] | B124-7 | B225-ECuSi |
| | Aluminum bronze 91% Cu 9% Al | (6) | | Grade WPALB[2] | B124-11a | B225-ECuAl-A1 |
| | Cupro-Nickel 70% Cu 30% Ni | (6) | B111-70 Cu-30 Ni | Grade WPCN[2] | B122-5 | B225-ECuNi |
| Aluminum and aluminum base alloys | 99.6% Pure aluminum | B345-1060 | B210-1060 B234-1060 B235-1060 | B361-WP1060 | (6) | B285-ER1060 |
| | Commercially pure low strength aluminum alloy | (6) | | B361-WP1100 | B247-1100 | B285-ER1100 |
| | Aluminum base manganese alloy | B241-3003 B345-3003 | B210-3003 B234-3003 B235-3003 | B361-WP3003 | B247-3003 | B285-ER1100 |
| | Aluminum base magnesium alloy | B345-5052 | B210-5052 B234-5052 B235-5052 | B361-WP5052 | (6) | B285-ER5254 |
| | | B345-5154 | B235-5154 | B361-WP5154 | (6) | B285-ER5254 |
| | Aluminum base magnesium silicon heat treatable alloy | B241-6061 B345-6061 | B210-6061 B234-6061 B235-6061 | B361-WP6061 | B247-6061 | B285-ER4043 |
| | | B241-6062 B345-6062 | B210-6062 B234-6062 B235-6062 | B361-WP6062 | B247-6062 | B285-ER4043 |
| | | B241-6063 | B210-6063 B235-6063 | B361-WP6063 | (6) | B285-ER4043 |

[1]When fittings are of welded construction, the fitting manufacturer shall supplement the grade symbol marking with the letter "W."

[2]No ASTM specification has been written. The welding fitting grade symbol is that recommended by MSS Standard SP-25, and the raw materials shown are those commonly used.

[3]The numerals in these grade symbols are the first two numbers of the minimum guaranteed yield strength of the fittings. Fittings having other minimum yield strengths may be similarly designated by using the applicable numerals.

[4]No ASTM specification has been written for welding rod of this composition. The symbol used has been generally adopted by welding rod manufacturers.

[5]Controversy exists as to the appropriate rod for welding this alloy. It is suggested that the welding rod manufacturer be contacted for specific recommendations.

[6]No ASTM specification has been written. However, materials having chemical and physical properties comparable to the other materials listed may be used.

# How To Improve Temperature Regulation On Instantaneous Heater Systems

By ERNEST GRAFE
Field Engineer
Spence Engineering Co., Inc.

TEMPERATURE, as a controlled variable, determines quality in a product at some point in most processes used by industry today. Consequently, proper regulation of temperature in commercial and industrial plants has become a key factor in maintaining operating efficiency and economy.

Poor regulation promotes waste; improving the regulation in most cases increases both production efficiency and product quality.

More and more frequently, instantaneous heaters are being put to use to serve a variety of process and other requirements. Such heaters depend upon fast and accurate temperature regulating systems.

Once it is established that waste or inefficiency are due to poor control, useful steps can be taken to improve temperature regulation. The operator's knowledge of his process, however, must be depended upon to recognize poor control as the culprit. The symptoms which he detects will determine the remedy. Unless the heat exchange system involved is well equipped with necessary gages and thermometers, only vague conclusions as to the reasons for poor control will be obtained.

### Basic Instruments Needed

To help spot such difficulties, almost any process system should have at least an initial pressure gage, a heater pressure gage, and a thermometer at the heater outlet. These are necessary and normal accessories.

A well instrumented heat exchanger will have pressure gages installed ahead of and behind the valve, plus thermometers at the heater outlet, and on critical installations, flow meters and recorders for pressure and temperature determination will also be included.

With such instruments, the general class of control weakness can be established.

### Control Failures Are of Three Kinds

Temperature control failures can be roughly divided into three classes: underheating, overheating, and erratic control.

Underheating and overheating are terms that are often used erroneously to describe generally insensitive control. In this sense, the meaning of the terms will depend upon how the individual sets the regulator. If he sets it to hold a certain upper limit with the system running steadily, a deviation in control that allows the system to override the upper limit will be called overheating.

Conversely, if the regulator is set to hold a lower limit, any deviation below this level will be called underheating. In fact, however, such conditions may be neither underheating nor overheating, but rather some type of erratic control.

If *insensitive* control is the basic problem faced, a natural first step would be to install a more responsive regulator. But such a change might also cause erratic control to develop.

### Underheating Indicates Undersizing

If underheating occurs, the odds are that at least one part of the system is too small. This raises certain questions which, when answered, will indicate the proper correction to be made.

1) *Is the heater big enough?* In general, a heater should be sized as small as possible for available steam pressure or for permissible tube surface temperature. Keeping the size to a minimum results in lower first cost, a more easily controlled heat exchanger, and simplified condensate removal.

The heater is too small, however, if with the maximum permissible steam pressure applied and the heater free of condensate, the required outlet temperature is not achieved.

**• Instantaneous heaters are used today for a wide variety of industrial and commercial processes. In many of these, the maintenance of one or more accurate temperatures during various steps in production is a critical factor for both product quality and efficiency. Therefore temperature control that is both fast and accurate is of prime importance. To get the most out of temperature regulating devices, each component of the instantaneous heater system must be assessed separately — in relation to the particular heating job to be done.**

A possible exception to this is the problem of the "air-bound" heater. If a vacuum breaker is installed on the unit, it is possible that air drawn in during a period of low load is killing some of the heating surface.

This air tends to blanket the heat exchange surface, excluding the steam, and causing underheating. One solution is to add eliminators to both top and bottom of the heater to meet the load changes. A better solution, from the control point of view, involves providing a means for draining condensate even while the heater is at a vacuum.

### What About the Condensate Drain?

2) *Is the condensate drain inadequate?* Flooding of the heater at high loads indicates that the trap or return line taking condensate away from the trap is too small.

Condensate retained in the heater will cover some of the heat exchange surface and prevent full use of the heater. A dirty trap or trap strainer may be the cause of the flooding. If condensate is not being removed fast enough there may also be too high a lift on the trap.

Since some instantaneous heater installations are not arranged to drain by gravity, regulator modulation which reduces steam pressure in the heater will tend to allow condensate to collect in the heater. This condition results in erratic control.

3) *Is the temperature regulator too small?* A falling off of pressure readings on the heater pressure gage coincident with increasing loads indicates that steam is not reaching the heater in sufficient quantity. Inability to maintain adequate pressure in the heater at maximum loads is the major warning signal here.

Condensation will take place faster than the steam is fed in if the regulator is too small. Proper sizing of the temperature regulator is achieved by maintaining an adequate balance between the factors of steam pressure, heater pressure, and load.

### Heat Source Must Be Adequate

4) *Is the steam supply insufficient?* — If the pressure gage ahead of the regulator shows supply pressure to be falling off below that required in the heater for maximum load, no regulator can prevent underheating.

Insufficient pipe sizes may be the simple cause. This can be determined by checking the gage at the steam source. If this gage indicates no substantial loss in pressure, it is likely that the line is too small.

It is also possible that there is an obstruction in the line or that a valve on the line is not fully open.

### Maybe Demand Exceeds Supply

Another possibility is that the steam demand is actually greater than the supply. In this case it is usually necessary to install additional generating equipment. At times it is possible to level out load variations (by adding "storage" in the heated system) to keep the peak within the capability of the steam source.

Enlarging the heater, or installing additional heaters in an attempt to add heating surface as compensation for a lower heater pressure, is almost never a suitable correction.

### True Overheating Is Unlikely

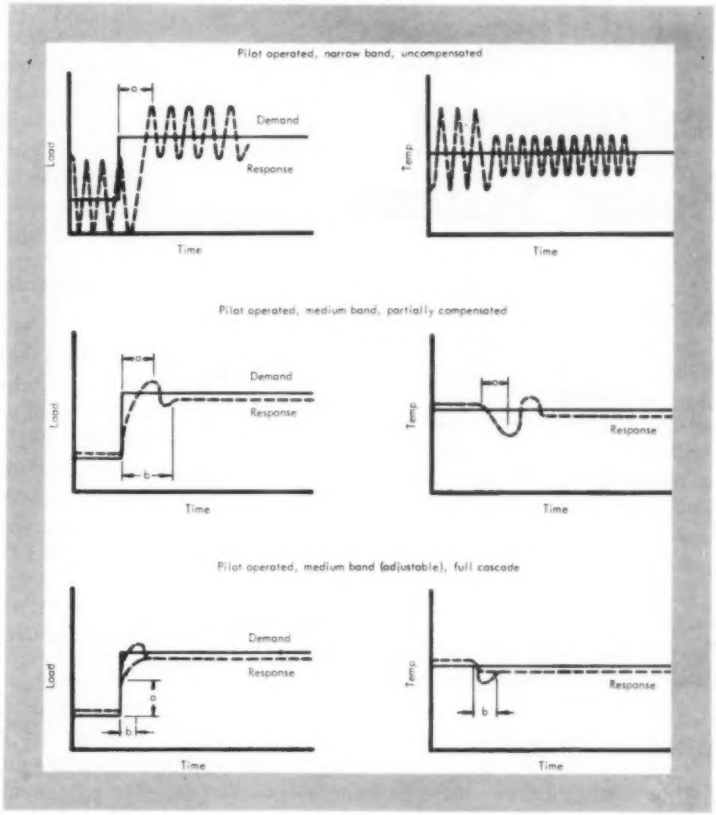
True overheating occurs only infrequently. The usual cause is a leak of steam from the regulator or from the by-pass around it. If the steam leaks in quantities too great for reduced load conditions, the result will be overheating.

Sometimes pressure in the return line may be such that when the regulator shuts off, condensate in the return will flash to steam and return through the trap to the heater and thus cause an overheating problem.

### Erratic Control Is "Temporary"

Erratic control is sometimes referred to as over or underheating (which were discussed in their true sense above). Actually erratic control exists where transient conditions result in temporary or sometimes oscillatory variations in temperature beyond acceptable limits.

This brings us to a basic and unavoidable problem in establishing accurate temperature control.




**1** PLOT of load and temperature variations *vs* time for three types of pilot-operated regulators which might be used on instantaneous heater systems. Text discusses nature of control problem and means to alleviate difficulties

Heat has to be transferred to and from the thermostatic system if it is to function and effect control. The thermostat has a substantially constant mass and a fixed area in contact with the fluid whose temperature is being measured. These two phenomena produce the problem of "time-lag."

### Time Lag Is of Two Kinds

In general, therefore, the rate at which a thermostat can respond is directly dependent on the deviation in temperature from the initial condition — that is, the greater the deviation, the faster the thermostatic action. For small deviations there may be appreciable time lag in the response of the control system. This is measurement time lag.

In addition there may be a time lag in the process itself — for example, where the thermostat bulb can only be located at some distance from the heater. Measurement time lag added to process time lag, in a system otherwise suitable, can be the source of the difficulty.

Measurement time lag is inherent in any system, and unavoidable since heat transfer and mass are unavoidable. But it is possible for the operator in many cases to relocate a thermostat nearer to the heater in order to obtain satisfactory control.

Where this can be done, reinstallation of the thermostat should be done according to the manufacturer's instructions. It has been found, in one instance, that simply tipping a thermostat bulb from a vertical to horizontal position, as the manufacturer originally recommended, has provided accurate control.

### System Lag Is The Major Problem

Process and measurement time lags, it is safe to say, are the major causes of erratic control. This is most clearly seen in the simple process system that runs for some time at essentially fixed load and then is subject to a quick change to a new load condition.

With the usual temperature control device, such a system will evidence a detectable period of time following a load change in which the temperature deviates from the set point while the regulator adjusts itself to the new conditions.

Sometimes the control device most suitable for such a system is based on maintaining a temperature very accurately at a fixed load condition. Such a device will sometimes oscillate temporarily, in terms of the controlled temperature, after an abrupt change. While this oscillation is in progress, observation of the valve movement in comparison with the temperature change will often indicate the presence of time lag in the process or the thermostat.

# Regulating Instantaneous Heater Systems

The pilot operated regulator uses a thermostat signal of relatively low power to operate a small pilot which directs auxiliary power for more sensitive control of wide ranging loads, and for quicker response to fast changing loads.

The basic principle on which most pilot-operated regulators are based is such that the main valve is operated by the pilot on changes of 1 to 2 F in temperature. The narrow throttling range, however, tends to introduce instability in controlling most really fast-changing load situations.

Widening out the proportional band of the regulator to produce stability is an intermediate solution. But this wide band may produce a response that is either too inaccurate or too slow.

### Action May Be Anticipated

Many changing load conditions occur so fast that they require a certain amount of anticipation in order to achieve accurate control. It was to provide this slight edge of anticipation that another type of regulator was developed.

In this type of regulator the pressure control portion of the pilot operates to anticipate a correction when a load change occurs. It does so on the basis of the heater pressure change that begins to take place whenever the load changes.

This type of regulator tries, without completely succeeding, to hold the heater pressure to a fixed value until the thermostat signals the pilot that a change is needed. This thermostat action comes later because of the unavoidable time delay mentioned above.

### Air Control May Be Answer

A system that actually does hold the heater pressure constant with fast changes in load is the air controlled temperature regulating system. This kind of system employs an air supply regulated by the thermostat to load the pilot on the regulator. This constitutes a "cascade" type of control such as is used by the instrument industry for the more difficult control jobs.

For most critical heater applications, additional control signals from other sources can be used to anticipate thermostatic action with its built-in time lag. For example, the pressure drop across the water side of the heater can be used in some cases to act as an anticipatory control. But this type of sophisticated control system is not necessary for the majority of commercial temperature regulating installations.

Fig. 1 plots load and temperature variations against time for each of three different types of regulator.

### Fixed Characteristics Are Measurable

The process of heat exchange normally takes place in a heater that has certain relatively fixed measurable characteristics. The surface area of the heat exchanger tubes, their coefficient of heat transfer, and the liquid velocity at a given load which governs the amount of time spent by a particle of water subjected to heat in the heater, are all relatively constant characteristics in a heater at some specific load condition.

### Temperature Difference Is Control Means

Only one factor can be varied to any degree by a regulator to control the temperature in a heater. This factor is the difference in temperature between the heating fluid (steam) and heated fluid (water). The relationship of these factors is shown in the simplified heat transfer formula:

$$Q = U \times A\ (t_s - t_w)\ T$$

*where*

$Q$ = total heat flow in Btu per hr

$U$ = a coefficient measuring the rate at which heat can be conducted from the heating to the heated fluids with given tube materials

$A$ = the area of heat transfer surface

$t_s - t_w$ = the temperature gradient between the heating and heated mediums

$T$ = the time during which a particle of the heated medium is in the exchanger and subject to heating

The coefficient of heat transfer $U$ is constant except for a minor variation with liquid velocity through the tubes. The area of the heater design remains fixed although there are heat exchangers designed to vary the effective area by the modulating action of the temperature regulator. These are not used in sufficient numbers to warrant discussion.

The time factor $T$ depends on the velocity of liquid through the tubes and the length of the tubes. This velocity in turn is established by the aggregate cross-sectional area of the tubes as against the rate of water flow in cfm.

The time factor actually has an adverse effect since the lower the load (and therefore the more sensitive

the system would be to small changes) the longer the time lag before the water from the heater reaches the thermostat.

In addition, when less heat transfer is required the water is in the heater for a longer period and thus subject to more heat gain.

The temperature on the water side ($t_w$) can be considered as an average (not arithmetic) between incoming and outgoing temperatures. The heat exchange formula is much simplified in the temperature expression, but the simplification serves to point up how a regulator controls heat transfer.

### Steam Temperature Is Control Factor

The control factor which the regulator manipulates is the steam temperature ($t_s$). It does this by varying the steam pressure in the heater. In general, a reduction in steam pressure effects a reduction in steam temperature. Except for negligible variations caused by superheat, the steam temperature varies in accordance with the saturation temperature curve.

To shut off heat flow ($Q$) entirely, $t_s$ must equal $t_w$. If $t_w$ is below 212 F, to stop heat flow $t_s$ must go below 212 F too. This means going below atmospheric pressure with steam in the heater. The removal of the resultant condensate under this operating condition is rarely provided for. As a consequence heaters develop "hammer" when condensate collects. To prevent heaters from going below atmospheric pressure, vacuum breakers are often installed to provide continuous drainage.

### "On-Off" Action May Occur

When this arrangement is used there is a portion of the load range through which the temperature regulator is not able to function reliably. A regulator faced with this situation frequently operates only on an "on-off" basis.

At the time the regulator supplies steam after an off period, the heater coils have become partially blanketed by air. This retards the installation's ability to maintain the required output temperature until the blanketing air is removed. This process time lag permits a falling off of controlled temperature.

In response, the regulator opens wider. Unless the heated fluid is moving very quickly through the heat exchanger, there is a period of time after the air has been blown out when overheating can occur. This is sensed by the regulator only after some of the overheated fluid reaches the thermostat. The regulator will then close and thereby start a repeat of this cycle.

### Compensatory Design Possible

Where vacuum breakers are used, there are two things to do: 1) install substantial air eliminating capacity and 2) reduce heater capacity to a minimum and thereby reduce the range of load over which subatmospheric control will be required. Too much heater capacity also has the adverse effect of narrowing the overall pressure range through which the regulator may work, making its job more difficult.

### Recirculating Loop Cuts Lag

At best, the thermostat on a fast-changing or instantaneous type heater can sense only a local condition, not the average condition through the heater. For most cases of this sort the most valuable solution is an external recirculating loop with a good circulator. Such a loop provides the thermostat with the ability to monitor continuously the conditions in the heater with a minimum time lag.

### Correct Sizing Important

Any regulator that operates at a small percent of its capacity can become unstable by itself or as part of a control system. Even when it is controlling higher load ranges of the system, it is still functioning at only a moderate portion of its capacity and the regulator can be over-responsive. This coupled with the inherent time lag can make the system as a whole unstable.

### Use Simple Design Rules

The whole control system rather than the temperature regulator, or any other single component, should be designed to achieve ultimate control stability. There are three basic rules that can be derived from this discussion which can be used as a guide in choosing suitable components, and in selecting the proper sizes.

1) Size the heater as small as possible.
2) Size the regulator for the smallest possible capacity between steam pressure, heater pressure and load.
3) Provide adequate condensate drainage for all operating ranges, and particularly for a vacuum condition when this is still in the operating range over which control is required.

### Select "Up" for Insurance

If there is any doubt as to how difficult the regulating job is that has to be done, it is best to choose the more advanced type of regulator from those outlined here. Hot water loads can vary quickly and over wide ranges. Safety is also a primary consideration.

Even if it turns out that the more advanced type of regulator is not really necessary, it will still provide better control than a regulator of lesser capabilities. ⧺

## the law and your profits

**JOHN F. MORRISSEY, author of this regular feature, is an attorney at law and has an extensive practical business and legal background. This series is based on actual cases. All names are, however, fictitious. It should, of course, be remembered that the law varies in different states.**

# Out-of-Court Arbitration Agreements May Themselves Occasion Court Action

IN ORDER to eliminate expensive court action on disputes arising out of installation contracts, the parties may enter into what is known as an *arbitration agreement.* Such an agreement provides for some method of resolving the conflict outside of court. Ironically, sometimes the arbitration agreement itself becomes a subject of dispute and, as in the following case, the parties find themselves in court.

For the contracted price of $15,000 the Lowe Cold Air Co. installed an air conditioning plant in the Tropical Theatre. The theater paid $3000 at the time the contract was signed, but refused to pay the balance on the ground that the system inadequately cooled the theater.

In the hope of resolving the matter, they entered into an arbitration argeement whereby Lowe was to place with the Third City Bank the sum of $3000 and Tropical the sum of $12,000 — the total amount to be held in escrow by the bank.

The condition of the agreement was that a test was to be made between the hours of 2 and 3 PM on a certain Sunday in August with a theater audience in attendance; and further, that the plant having been on for a reasonable length of time should maintain a 15 F temperature difference between the inside and that recorded in the shade outside.

If the conditions were met the bank was to deliver the money to Lowe, but if not the money was to go to Tropical, with Lowe having the right to remove the air conditioning equipment.

After Lowe claimed that the conditions of the test were met and Tropical that they were not, the bank filed an "interpleader" in court to find out which one had a right to the money.

The evidence showed that Lowe's engineers started the plant at 6 PM on the day before the test and continued operation through the test period. They also placed three thermometers flat on the floor of the theater. Another they placed in a narrow space between two buildings, under the eaves of one. The other building was painted white and the sun shone directly upon it.

Tropical's representatives objected to conducting the test in such a manner, but Lowe's engineers proceeded with the test and succeeded in showing a temperature differential of 15 to 18 F.

Tropical offered evidence in court that the air conditioning system was inadequate to cool the theater 15 F under ordinary circumstances. The test, Tropical contended, was unreasonable, purposely deceptive, and conducted in bad faith by Lowe. The outside thermometer, because of its position under the eaves in a place where there was little air circulation and where the sun was reflected by the white paint, was 6 to 9 F higher than the average shaded temperature.

Also, Tropical argued, placing the thermometers on the floor of the theater was unfair, since they recorded temperatures about 3 F lower than thermometers placed 30 in. above the floor. Then too, said Tropical, running the plant from 6 PM the preceding day was an unreasonably long time for the system to accomplish the requirements of the test.

Objecting to Tropical's argument, Lowe pointed out that the arbitration agreement said nothing about specific locations of the thermometers or about the length of time in which the plant could operate before the test. The agreement, said Lowe, provided that our engineers should have full control to conduct and supervise the test. They conducted it in the manner in which they saw fit without violating any terms of the agreement.

Specific terms of the agreement may not have been violated, said the court, but it was incumbent upon Lowe to exercise good faith in carrying out the terms of the contract so as to comply with the intention of the parties and to accomplish the purpose for which it was made. The clear intention was that a fair test be made.

The court found the evidence to indicate bad faith on the part of Lowe, and that if the test had been conducted under reasonable conditions the results would probably have been unfavorable to Lowe. The bank was directed to pay the escrow to Tropical. ⧺

# How to Determine Pressure Drop for Water Flow In Pipes of Various Materials

By JOHN D. CONSTANCE
Professional Engineer

A USEFUL tool for determining pressure drop in pipes when full and under pressure is the Hazen-Williams formula:

$$v = cr^{0.63}s^{0.54}0.001^{-0.54}$$

*where*

$v$ = mean velocity, fps
$r$ = hydraulic radius, ft
$s$ = hydraulic slope, ft per ft of length
$c$ = Hazen-Williams coefficient for roughness

The Hazen-Williams formula may also be written

$$v = 1.318cr^{0.63}s^{0.54}$$

Table 1 gives values of the coefficient for roughness which may be used for computing pressure drop due to friction in pipe for which the coefficient equals other than 100.

This formula was designed with a view towards obtaining a minimum variation in the value for $c$ for all conduits of the same degree of roughness. That is, the object was to select values for the exponents such that $c$ would be, as nearly as practicable, a function of the degree of the roughness of the conduit surface, rather than a function of the hydraulic radius and slope.

These values of $c$ depend on the smoothness and regularity of the internal surfaces, and are likely to vary in individual cases.

The chart on the following page is a simple graph for quickly finding the pressure drop for water, based on the Hazen-Williams formula and valid for a coefficient, $c$, of 100. The shaded area indicates the limits often used for good practical values of pressure drop. However, in order to apply the results obtained from the graph, we can correct the pressure drop values by using a multiplying factor.

The pressure drop for any value of $c$ (for different kinds of conduit as obtained from Table 1) may be determined by multiplying the graph value by

$$(100/c)^{0.54}$$

Table 2 lists various factors to be used with $c$ when the value of the coefficient is other than 100.

Note that the graph is correct for turbulent flow only, when the Reynold's Number is greater than 2100. Velocities greater than 3 fps indicate turbulent flow. For practical purposes, results are acceptable for water temperatures up to about 90 F, although the graph is based on a water temperature of 60 F. Results for colder water would also be useful for estimating purposes.

TABLE 1 — VALUES for the coefficient of roughness, $c$, for use in Hazen-Williams formula for computing pressure drop in pipe

| Kind of pipe | Coefficient of roughness, $c$ |
|---|---|
| **Cast iron** | |
| New, well laid | 130 |
| 4 to 6 yr old | 120 |
| 10 to 12 yr old | 110 |
| 13 to 20 yr old | 100 |
| 26 to 35 yr old | 80 |
| **Asbestos cement** | 140 |
| **Cement lined** | |
| Applied by hand | 125 |
| Applied by centrifuge | 140 |
| **Riveted steel** | |
| New (66 to 144 in.) | 110 |
| 10 yr old | 100 |
| Over 10 yr old | 95 |
| **Fiber pipe** | 140 |
| **Bitumastic lined** | |
| Iron or steel | 140 |
| **Copper, brass, lead** | 130 |
| **Tin, or glass pipe** | 130 |
| **Wood stave pipe** | 110 |
| **Welded and seamless** | 100 |
| **Wrought iron** | 100 |
| **Concrete pipe** | 100 |
| **Vitrified pipe** | 100 |
| **Corrugated steel pipe** | 60 |
| **Tile pipe** | 110 |
| **Brick pipe (sewers)** | 100 |
| **Fire hose** | |
| Extremely smooth | 143 |
| Rubber lined | 125 to 140 |
| Mill hose | 100 to 120 |
| Unlined linen | 85 to 95 |

**Example 1**

Given a water flow rate of 20 gpm, what, generally, is the line size which should be used for practical purposes?

*Solution*: From the graph, a 2 in. line size falls within the shaded (acceptable) area, and yields a pressure drop of 0.66 psi per 100 ft.

**Example 2**

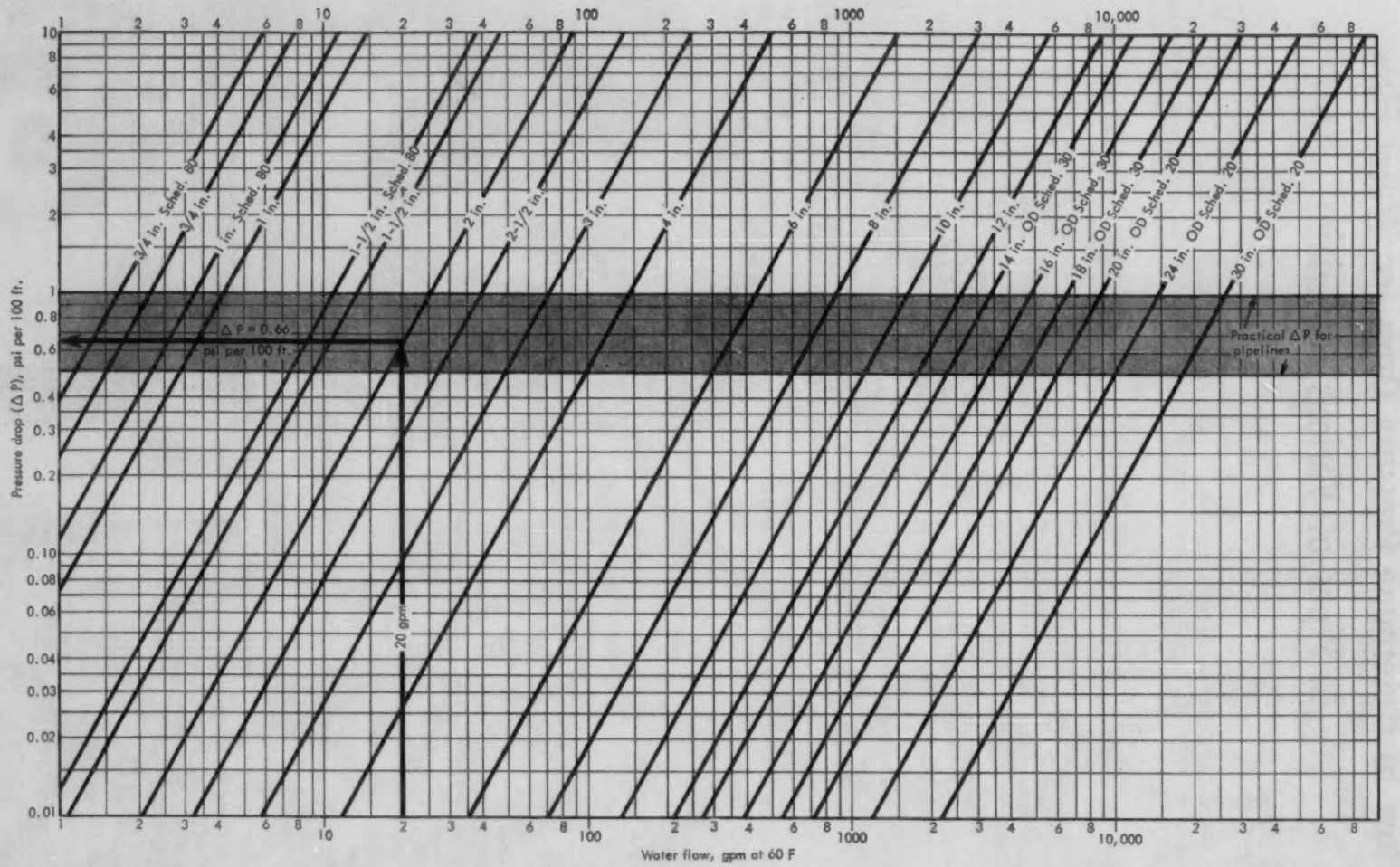
For the same flow and line size, but using copper pipe, what would be the pressure drop?

*Solution*: From Table 2, the factor for copper pipe, where $c = 100$, is 0.6152. Therefore the pressure drop for copper pipe is equal to $0.66 \times 0.6152 = 0.41$ psi per 100 ft. ⧺

TABLE 2 — FACTORS to be used with coefficient, $c$ of other than 100

| Coefficient, $c$ | Factor |
|---|---|
| 60 | 2.575 |
| 70 | 1.936 |
| 80 | 1.512 |
| 90 | 1.215 |
| 100 | 1.000 |
| 110 | 0.8382 |
| 120 | 0.7135 |
| 130 | 0.6152 |
| 140 | 0.5363 |
| 150 | 0.4683 |

HPAC DATA SHEET

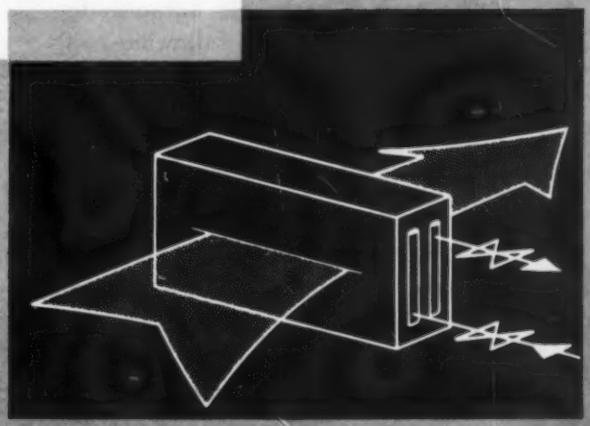



**PRESSURE DROP** for water flow in pipes of various materials can be determined from chart, above, which is based on Hazen-Williams formula and coefficient of roughness, $c$, for different materials. Chart assumes $c = 100$. For coefficients other than 100, see conversion tables on preceding page

HPAC ENGINEERING DATA FILE

# How to Provide Freeze-Up Protection For Heating and Cooling Coils

- *Freeze-up experience reported*
- *Air mixing and stratification*
- *Steam heating coils*
- *Hot water heating coils*
- *Idle chilled water coils*



FAILURE to provide adequate freeze-up protection for heating and cooling coils at various stages in a system's life-cycle may result in costly damage to a coil and related property damage of even greater proportion if leaking water inundates occupied spaces. No single collection of system components at present will completely eliminate the need to consider freeze-up protection during manufacture, design, installation, and operation. Some arrangements may be more prone of freezing than others. However, with proper attention and application of existing knowledge at each stage in a system's life-cycle, and with proper coordination of the various components, the incidence of freeze-ups can be reduced to a practical minimum.

It is of interest that freeze-ups are apparently becoming more prevalent, or the willingness to discuss them is more prevalent, even though much has been learned from field research and unfortunate experience about the causes and ways to prevent them. This may in part be attributed to the increasing use of hot water for heating in central fan systems, and the increasing use of chilled water for cooling in place of direct expansion coils.

The freeze-up incidence of chilled water coils can be attributed in part to the desire of the building management to have the cooling system in readiness at all times of the year. Because of high internal heat gains brought about by increased use of electric energy for lighting, office machines, etc., cooling is often desirable on mild days during what a few years ago was considered the midpoint of the heating season. Electric loads, with the exception of the last two years, have been growing[1] at the rate of 6 percent per year in commercial buildings because of the changes in lighting standards and office procedures. For this reason, more attention must be given in design and installation to system arrangements which will permit operation of the cooling system on short notice, or perhaps continuously, regardless of calendar date.

In this report, the causes of freeze-ups and ways of providing freeze protection for coils which for one reason or another may be exposed to air at sub-freezing temperatures are presented. Attention is given here only to central systems in which steam, hot water, and idle chilled water coils may be subjected to freezing during the winter or heating operation when the possibility of moving low temperature outdoor air over the coils exists. Other system elements which for one reason or another may be subject to freezing, such as chillers, pumps, etc., are not considered.

## Mechanical Contractors' Freeze-up Experience

At the recent meeting of the Mechanical Contractors Association of America, the results of a survey of the freeze-up experience of the members was reported[2] by A. I. McFarlan, presi-

**The editors gratefully acknowledge the cooperation of the following engineers who provided much of the information included herein:**

**W. J. Abraham, operating manager, The Merchandise Mart, Chicago**

**J. H. Clarke, engineering design supervisor, air conditioning and power, Visking Co., Div. Union Carbide Corp.**

**E. C. Hallanger, systems application engineer, & R. Crysler, sales manager, commercial division Minneapolis-Honeywell**

**G. J. Haufler, engineer, John J. Nesbitt, Inc.**

**A. I. McFarlan, president, A. I. McFarlan Co., Inc., mechanical contractors**

**J. N. Scanlon, vice president, Kerby Saunders, Inc., mechanical contractors**

dent of A. I. McFarlan Co., Inc. The results of the survey are listed in Table 1 and Mr. McFarlan's discussion of the results are paraphrased below.

"There appears to be a reluctance on the part of owners and mechanical contractors to discuss their freeze-up problems. Yet it is only when we can examine many cases, such as those analyzed in Table 1, that reasonable conclusions can be reached. It is difficult to say whether the 35 replies received represents a cross-section of freeze-ups generally, but qualitative observations can be made on the basis of the information presented in the table.

"The replies indicate that the freeze-ups are not limited to any one type of coil. Hot water coils as well as chilled water coils froze both with and without steam preheat coils upstream. While hot and chilled water coils are considered individually, it is reasonable to assume that in many cases the same coil is used for both functions.

"It seems significant that 25 of the 35 freeze-ups were in systems having maximum-minimum outside air dampers. In one case, an explanation is given to the effect that the thermostat was calling for cooling, which opened the O. A. damper to the maximum position in a period when the outside temperature was below 32 F.

"The question of stratification is apparently one of the leading causes of freeze-ups. If variable quantities of outside air and return air are mixed by the automatic controls, stratification will vary continuously. The question is whether it is easier to control the stratification, or to eliminate it whenever air can be constantly recirculated by assuring fixed quantities of outside air and return air to be mixed and supplied to the coils at temperatures above freezing even on the coldest day.

"In the case of systems using 100 percent outside air at all times, there would seem to be fewer problems than when the quantities of outside air and recirculated air are continually varying. This probably is due to the fact that steam distributing tube heaters work more uniformly when the air temperature is the same over the entire coil face."

[1]*Numerals refer to references on page* 168.

**TABLE 1—FREEZE-UP EXPERIENCE of mechanical contractors was recently studied by the Mechanical Contractors Association of America. The results of this survey are given here for a limited return of 35 questionnaires. Though the scope of the results is limited, the data provide qualitative information on the subject of coil freeze-ups**

| | |
|---|---|
| **What types of coils froze?** | |
| Chiller | 1 |
| Hot water coil | 13 |
| Chilled water coil | 11 |
| Single tube steam coil | 1 |
| Double tube steam coil | 6 |
| Hot water coil downstream from DX refrigerant coil | 1 |
| Single tube steam and chilled water both froze | 1 |
| Double tube steam and chilled water both froze | 1 |
| **What was the outdoor temperature when the coil froze?** | |
| The temperatures reported ranged from −26 F to 30 F. | |
| Fourteen cases were within the range of 15 F to 25 F. | |
| In several cases, the temperature is unknown since the coil damage was not discovered until the end of the heating season when water was returned to the coil for cooling purposes after having been drained. | |
| **Did system have maximum-minimum outside air dampers?** | |
| Yes | 25 |
| No | 7 |
| 100 percent O.A. damper blocked open | 1 |
| **Under what condition did chilled water coil freeze?** | |
| Coils which had been drained | 10 |
| Of these 10, those supposedly flushed with anti-freeze | 3 |
| Those not flushed with anti-freeze | 6 |
| Not known whether or not they were flushed with anti-freeze | 1 |
| **Was pump in operation when hot water coils froze?** | |
| Yes | 3 |
| Unknown | 2 |
| Yes, but outdoor air damper blocked open manually | 1 |
| Yes, but power failed on damper | 1 |
| Yes, but thermostat calling for cooling | 1 |
| **Was outside air damper stuck open?** | |
| Yes | 11 |
| Unknown | 2 |
| Damper reported not tight | 4 |
| **Did freeze-up occur during sleet or snow storm?** | |
| Yes | 4 |
| Unknown | 1 |
| **Was preheat coil installed ahead of coil that froze?** | |
| Yes | 10 |
| Not answered | 4 |
| **Who assumed financial obligation for freeze-up?** | |
| No damage (chiller froze) | 1 |
| Mechanical contractor | 12 |
| Owner | 10 |
| Insurance company | 2 |
| Partially paid by mechanical contractor and manufacturer | 2 |
| Still under negotiation | 3 |
| Did not know or did not answer | 5 |
| **What was the extent of the damage?** | |
| For coil repairs | Varied from $75 to $15,000 |
| Property damage | Varied from "minor" to $40,000 |

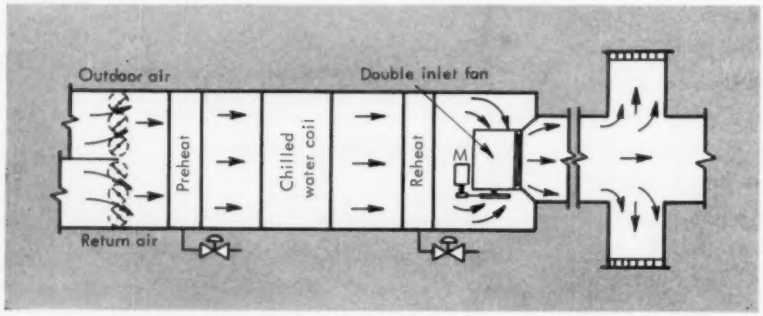
# Air Mixing and Stratification—A Common Problem

As noted earlier, stratification, which may be due to inadequate mixing of return and outside air, or uneven steam distribution in steam coils, is one of the principal causes of freeze-ups in otherwise well designed, installed, and operated systems. Since the problem is common to both steam and water coils, it is discussed here to avoid repetition.

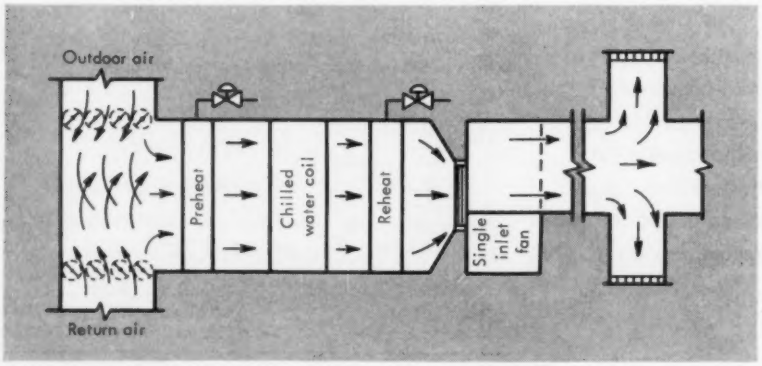
In general, return air and outside air in central air conditioning systems are mixed in proportions which will provide an average mixed air temperature above freezing. For example, even in the extreme case where equal volumes of air at 75 F and −10 F are mixed, the average mixed air temperature will be a *safe* 32.5 F. However, this may lead to a false sense of security, because poor mixing can result in sub-freezing air being drawn through the system even though the *average* mixed air temperature is theoretically above freezing. Idle cooling coils, and even active heating coils under certain conditions of operation may thus freeze up.

Fig. 1, reproduced from an article[3] by H. W. Alyea, Johnson Service Co., illustrates an undesirable fan unit arrangement as far as stratification is concerned. Outside air and recirculated air are introduced in parallel streams, which in themselves are difficult to mix. To increase the likelihood of stratification the parallel leaf dampers have been installed in such a way as to hinder mixing rather than aid it. The low temperature outside air moving through the unit introduces a freeze hazard for all of the coils through which it must pass. Additional complications occur because the double inlet fan will deliver the stratified air unmixed to the supply duct system making it difficult, if not impossible, to properly locate a control in the fan discharge that will sense the temperature of the air leaving the heating coil. An averaging thermostat will tend to minimize control difficulties but will not eliminate the potential freeze hazard upstream from the fan. Rotating the fan 90 deg with respect to its position in Fig. 1, will tend to promote some mixing of the stratified air.

With the arrangement in Fig. 2, from the same article[3], some improvement in the conditions over those of Fig. 1 would be expected. The




**1** POOR AIR MIXING and stratification will result with fan and end inlet arrangement shown here. As installed, dampers hinder mixing of parallel air streams. Condition causes unequal heat distribution, control problems, and exposes all coils to freezing hazards




**2** BETTER AIR MIXING is obtained with this arrangement as compared to that in Fig. 1 Outdoor air and return air streams are introduced at opposite sides of mixing chamber and dampers are arranged to increase mixing. Single inlet fan minimizes stratification problems in supply duct and control difficulties

return air and outside air are introduced at opposite sides of the mixing chamber and parallel leaf dampers direct the incoming air in such a manner as to increase turbulence and promote mixing. Opposed leaf dampers will also promote mixing in this type of arrangement. Further reduction in stratification can be obtained by taking advantage of the natural mixing resulting from the differences in air density by introducing the outdoor air into the top of the mixing chamber. The use of a single inlet fan in Fig. 2 mixes the stratified air thus minimizing stratification in the fan discharge and the control problems associated with it. However, a single inlet fan in a draw through arrangement will have no effect on the stratification upstream from the fan and freeze hazards caused by poor mixing will still exist.

The stratification and the direction of air flow in the arrangement shown in Fig. 2 will vary with damper modulation. Thus, the coldest air will not necessarily be found in the same location. The location of a freezestat downstream from the coil is critical and some difficulty may arise in determining the proper location which will protect the coil.

Two other factors which may promote poor air mixing and stratification, and should be given consideration in design are:

1) Abrupt turns immediately upstream from the coil — the air will tend to move to the outside of the turn thus producing unequal loading of the coil. Turning vanes, locating the filters between the coil and intake, or the use of an orifice plate will help to insure uniform flow.

2) Non-symmetrical return and outdoor air intakes — a single plane through the apparatus casing is shown in Fig. 2 but symmetry must exist in the plane perpendicular to the figure to insure adequate mixing and uniform flow. If the return extended over the full width of the casing and the outside air intake over a shorter distance, stratification would tend to increase.

One of the most effective methods of insuring adequate mixing of the entering return and outside air streams is by locating the coils downstream[4] from the fan. If blow-through design is provided, the air streams can be effectively mixed in the single inlet fan, in most cases, and the coils will never be exposed to sub-freezing air. However, control location may become a problem because of stratification.

Effective air mixing can be obtained also in a double inlet fan provided attention is given to the location of the fan inlets with respect to the incoming return and outdoor air streams. When the plane of the inlets of a double inlet fan is perpendicular to the plane of the stratified layers of air the mixing[4] through the fan is approximately 1 F in 3.5 F. That is, for every 3.5 F difference in temperature of the entering air streams there will be only a total variation of 1 F in the mixed air. Continuous mixing is assured regardless of the position or modulation of the entering air dampers, provided there are no end inlet sections (such as are shown in Fig. 1) nor severe end loading caused by the presence of 90 deg. turns without turning vanes.

Because the mixing process is a time related function, the distance between the mixing chamber and the first coil in the moving air stream will have an effect on mixing efficiency. The shorter the distance the greater will be the difficulty in obtaining good mixing.

# Freeze Prevention for Steam Heating Coils

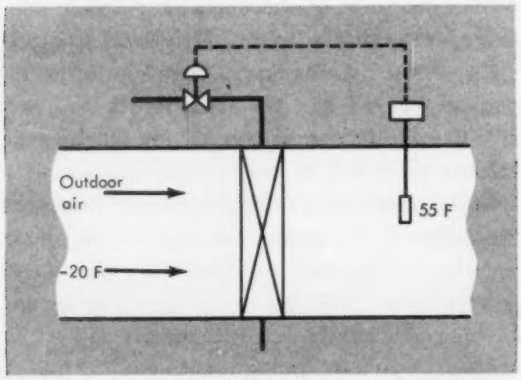
The availability of steam coils of the antifreeze or inner distributing tube type has minimized the incidence of steam coil freeze-ups. However, as noted in Table 1 the inner-distributing tube type of heater is still subject to freeze-up when not properly applied.

Two principal causes for steam coil freeze-ups are low condensate flow and waterlogged tubes. As noted by R. Crysler, systems application engineer, Minneapolis-Honeywell, at the Mechanical Contractors convention[5], a properly selected and installed coil with two-position steam service is not considered a freeze-up problem. Steam coils using proportioning control, however, can be a problem if the inner workings of the coil under all load conditions are not clear.

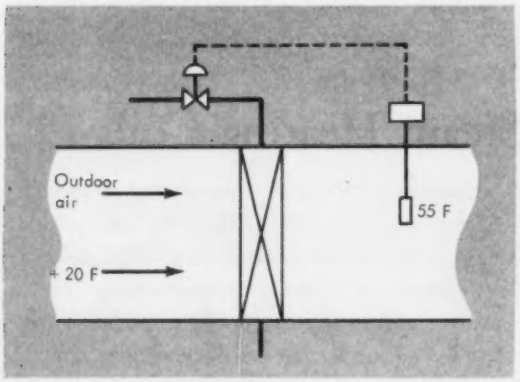
Capacity reduction of the coil at light loads can be accomplished only by reducing the coil mean fin temperature. This can be done only by

reducing the temperature of the steam in the tubes in one of two ways. First, as outlined by Mr. Crysler, the coil may remain full of steam at reduced temperature and, thus, reduced pressure. In this case, the total pressure in the coil is equal to the partial pressure of the steam. Only limited capacity reduction can be obtained in this way. For example, with atmospheric returns, only a 5 to 10 percent capacity reduction is obtained by reducing the pressure from 5 psig (225F) to 0 psig (212F). Larger capacity reductions would be experienced with a vacuum in the tubes, but condensate drainage becomes more difficult, if not impossible, as the vacuum is increased.

The second method of reducing the steam temperature is to reduce the partial pressure of the steam in the coil. This is what happens with proportioning control and very low absolute steam pressures can be obtained in this way. The total pressure on the condensing side of the tubes in atmospheric return systems remains at atmospheric pressure because air bleeds back into the coil through the vacuum breakers. In vacuum return systems, the mechanism is not so clear, but the steam bleeding back into the coil through the vacuum breaker will be at a lower temperature and control will be achieved.




**3** COLD WEATHER OPERATION of single preheat coil designed for high temperature rise with proportional control will not freeze as coil is full of steam




**4** MILD WEATHER OPERATION of coil in Fig. 3 will expose a general purpose coil to freeze-up hazard if proportioning control is used. This may also be an unsafe condition for "antifreeze" coils if other safe practices are not followed

To avoid a freeze-up hazard when the flow of steam to the coil is reduced, good steam distribution over the entire tube length is essential. This can be accomplished only by a carefully designed coil of the inner distributing tube type.

Mr. Crysler's remarks[5] concerning the inner distributing tube coil and selecting preheat coils for freeze protection are paraphrased below:

"Some 'non-freeze' type coils are available that can maintain distribution down to 10 to 15 percent of full capacity, other coils cannot distribute down to 50 percent successfully.

"It is unfortunate that meaningful industry standards do not exist for evaluation of steam distributing tube or 'non-freeze' coils. However, specifications for 'non-freeze' coils could require distribution (without extensive cold spots) down to, for example, 25 percent of full capacity and this would allow several manufacturers to bid, and would allow the engineer to use proportioning service coils with more safety.

"Figs. 3 and 4 show a typical high temperature rise coil installation. With the thermostat set for 55 F, during very cold weather the coil is full of steam and will not freeze. But in mild weather, the air coming into the coil is at say 20 F. The controller still set at 55 F, will have to pinch the valve down until it is putting out only 47 percent of rated capacity. Part of the coil is starved of steam and there is no pressure in the coil. The only force draining water out of the tubes is gravity. This constitutes a freeze-up hazard for general purpose coils, and may be a freeze hazard with 'non-freeze' coils if other safe practices in coil selection and installation have also been ignored.

"One cure for this situation is multiple preheat on-off control of a coil or coils ahead of the

proportioning control coil. Figs. 5 and 6 show such an installation. Coil I is controlled on-off from outdoor temperature. The second or proportioning coil is controlled from discharge temperature as before. During cold weather, as shown in Fig. 5, both coils are full of steam and no freeze hazard exists for a properly installed coil.

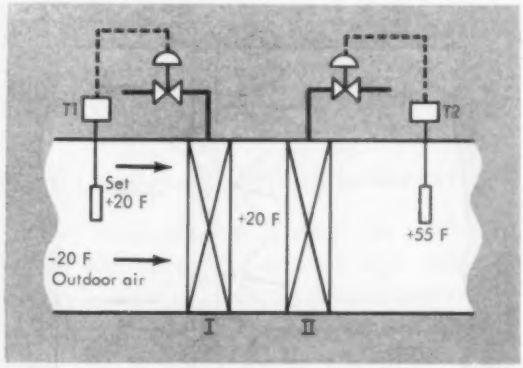
"When the outdoor temperature rises to 25 F as indicated in Fig. 6, coil I will shut off and air enters coil II at 25 F. However, since the coil is selected to raise the air temperature only 35 F at full capacity, with coil I shut off, coil II will have to operate at 87 percent of capacity when the incoming air is at 25 F. With the incoming air at 32 F, coil II would be required to operate at 66 percent of rated capacity. Thus, a properly designed 'non-freeze' coil would be capable of operating with minimum freeze-up hazard."

J. H. Clarke, in his recent series of articles[6], has made the following observations about the method of control proposed in Fig. 6. "This system is a carryover from the old days when steam distributing tube air heaters were not available. It is still very popular. Strictly speaking, two-position preheater valves are not used because the sudden opening of such a valve causes undesirable thermal stress in the preheater, sets up a serious water hammer condition, and requires rapid readjustment of the reheater control to maintain the desired temperature.

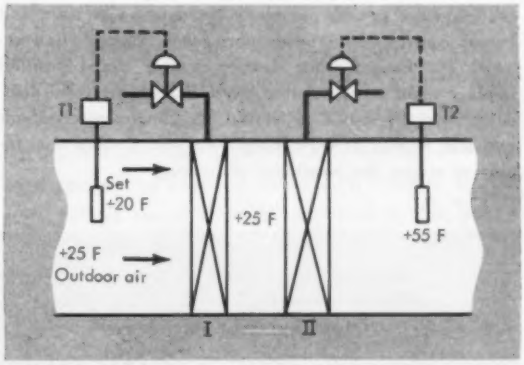
"Usually the steam valve is opened by a proportioning thermostat, over a 10 to 15 F range. For example, as the outside temperature drops from 45 to 35 F. The reheater control valve (coil II) would be modulated by means of the discharge thermostat." Mr. Clarke goes on to note that while freeze protection is provided, this system requires careful coil selection to prevent overheating and to assure satisfactory control.

It should be apparent that in a central air conditioning system with the coil located downstream from the mixing chamber, a single inner distributing tube type heater with proportioning control will function with minimum freeze-up hazard providing the following things are true:

1) Outdoor air and return air are adequately mixed upstream from the coil.




**5** MULTIPLE PREHEAT COIL installation minimizes freeze-up hazard. Coil I operates with on-off control and is always full of steam when air temperature is below 20 F. Coil II is designed for 35 F rise and is operated with proportioning control. In cold weather Coil II is also full of steam, thus, minimizing freeze hazard

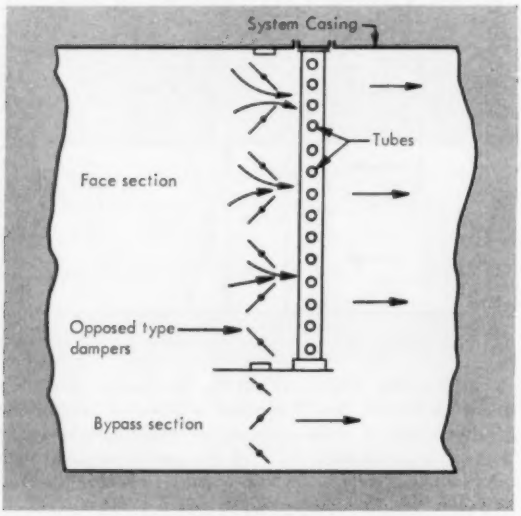



**6** MILD WEATHER OPERATION of multiple preheat causes coil I to shutoff. Coil II operates under proportioning control at 87 percent of capacity at condition shown to minimize freeze hazard when distributing tube coil is used

2) The coil sizing is made to satisfy the heating load without safety factors except for a 10 percent dirty tube factor. This is to insure operation at as high a percentage of capacity as possible when freezing conditions occur. Maintaining a well loaded heater is most easily done with a single row coil. Two row coils will not be sufficiently loaded unless wide fin spacing is used. Also, the two row coil may load up unevenly with the second row taking the load, thus making the first row vulnerable to freezing.

3) The most important[4] single factor is that proper provisions have been made for draining the condensate.

4) The coil is designed to maintain good steam distribution down to a small percentage




**7** OPPOSED LEAF DAMPERS, located too close to air heaters, have caused numerous freeze-ups with face and bypass control despite wide open steam valves. High velocity jets formed when damper is near closed position impinge upon tubes to cause freeze hazard. To avoid difficulty, dampers should be moved back from heaters about two leaf widths, at least. Larger air heater tubes also appear to reduce the possibility of freezing

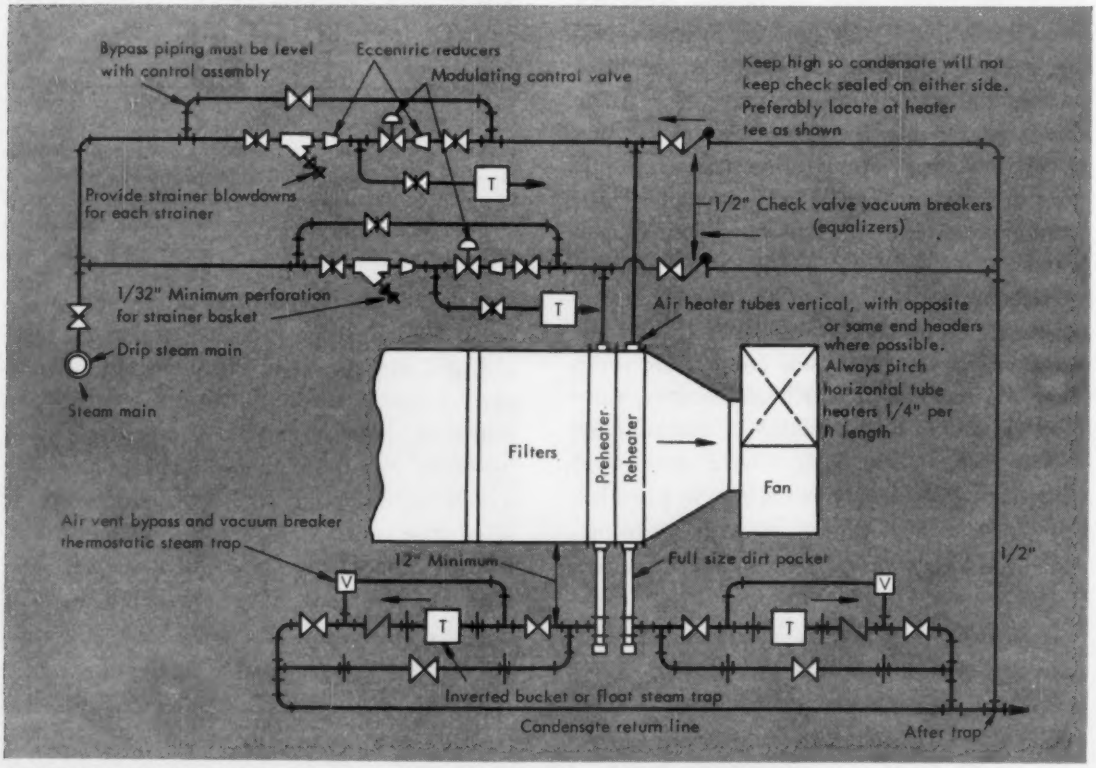
of its full load design capacity.

## Consider Vertical Tube Arrangements

Installation of heaters with the tubes vertical is preferred by many engineers to assure positive drainage, thus reducing the possibility of freezing. A horizontal coil given careful handling and good installation will perform satisfactorily, however, experience indicates that the tubes are often bent during shipment or installation. Pockets which hold condensate and increase freeze hazard result. When installed horizontally, the tubes should be pitched ¼ in. per ft for good drainage.

## Exceptions to Every Rule

The inner distributing tube heater will be adequately protected down to a low loading for the conditions described above except under unusual conditions such as are illustrated in Fig. 7.


Bypass piping must be level with control assembly
Eccentric reducers
Modulating control valve
Keep high so condensate will not keep check sealed on either side. Preferably locate at heater tee as shown
Provide strainer blowdowns for each strainer
1/2" Check valve vacuum breakers (equalizers)
1/32" Minimum perforation for strainer basket
Air heater tubes vertical, with opposite or same end headers where possible. Always pitch horizontal tube heaters 1/4" per ft length
Drip steam main
Steam main
Filters
Preheater
Reheater
Fan
Air vent bypass and vacuum breaker thermostatic steam trap
12" Minimum
Full size dirt pocket
1/2"
Inverted bucket or float steam trap
Condensate return line
After trap

**8** GOOD STEAM PIPING PRACTICE from freeze protection standpoint is illustrated here. Note that vacuum breaker is connected at steam side of heater, but also note that air vent bypass over steam trap will tend to break any vacuums on condensate side which may occur while pressure still exists on steam header. See text for comments on desirable minimum distance between heater outlets and traps

In the situation depicted, face and bypass dampers are used for control and for added freeze protection. Because the opposed-leaf damper has better control characteristics than the parallel leaf damper in most installations[7], they have been used with increasing frequency for face and bypass control. When conditions are near freezing, the face damper approaches the closed position, and the air stream is broken into a number of parallel, high velocity streams as shown. A considerable distance is required before these jets will expand to fill the duct. If the dampers are located close to the coil face, and the air is below freezing, the impingement of the high velocity jets on the tubes may cause a freezing situation. Mr. Clarke noted in his article[6] that several freeze-ups of this type had been experienced. To remedy this situation, especially in systems employing 100 percent outside air, the opposed-leaf damper should be moved back from the face of the coil by at least two leaf widths or located to prevent impingement.

## Good Piping Practice

One of the most important considerations in designing for freeze protection of coils which are valve controlled is providing for proper condensate draingage. This problem is particularly severe in 100 percent outside air installations. A piping arrangement which provides maximum freeze protection and represents good practice is illustrated in Fig. 8. This figure is reproduced from the articles[6] by Mr. Clarke, and while it pertains particularly to makeup air systems, the principles are equally applicable to any system. Mr. Clarke's comments concerning piping design and selection of components are summarized below.

## Place Control Valve at High Point

"The piping should always be designed with the control valves located at a high point with respect to the steam main and the air heaters. This permits the condensate to drain either way during shutoff conditions. Where this is not possible, drip traps should be provided ahead of and following the controls to avoid accumulation of condensate. This will prevent one cause of water hammer and resultant heater damage. It will also avoid a water condition which could cause freezing."

## Pitch Condensate Piping to Receiver

"The condensate piping should be uniformly pitched and should be free of high spots or pockets in its run to the condensate receiver — whether atmospheric or vacuum. The condensate should not be discharged at a level above the trap, nor should the condensate pipe be led above this level at any point between the trap and the receiver because modulating valves also act as pressure reducers. At partial loads when the control valve is nearly closed, the steam pressure may not be sufficient to discharge condensate against a positive head. Actually, vacuums in excess of 22 in. Hg have been observed in air heaters under such circumstances. Obviously, in such cases, it is not possible to discharge condensate above the trap or heater. A flooded heater will freeze rapidly when exposed to air below freezing temperature."

## Provide Dirt Leg

"Condensate piping sizes smaller than ¾ in. are not recommended. The piping from the heater should be run to a full size dirt leg at least 12 in. deep (and preferably deeper). The trap connection should be made about 6 in. above the bottom of this dirt leg and should be reduced to the size required for the condensate capacity.

"Strainers should always be provided ahead of the control valves to keep scale and dirt from lodging on the valve seats and from clogging the small orifices in the steam distributing tubes of the air heaters. Steam strainer basket perforations or mesh should be at least 0.045 in. or 1/32 in. Particles which will go through these openings are not apt to cause control valve, heater, or trap trouble. Smaller openings increase possibility of plugging and increase freeze hazard. Where used, condensate strainer perforations should be 1/16 in. diameter or mesh.

"There is much difference of opinion as to whether or not strainers should be provided

ahead of the steam traps. Where a control valve strainer is provided and maintained as it should be, and an ample dirt leg provided, the condenstate strainer can be eliminated."

## Select Traps Carefully

"Either float or inverted bucket type steam traps may be used. Combined float and thermostatic traps, though often recommended for this service, should be used with caution because the thermostatic elements tend to be unreliable. By providing a thermostatic trap over the steam trap for air venting, the thermostatic element will not be subjected to condensate sludge."

## Provide Steam Trap for Each Heater

"A steam trap should be provided for *each* air heater of a multiple heater installation. The trap capacities should be based on realistic differential pressures across the trap, taking into account steam line friction, control valve and air heater losses, and the back pressure or vacuum in the condensate line. The steam traps should be selected for the air heaters so that the greater than normal 'startup' loads of condensate can be quickly drained from the air heaters, and to provide adequate air venting capacity."

"Steam should always be on the air heaters before the ventilation systems are started in cold weather. If proper procedure is followed, excessive starting-up load will not occur."

## Where To Locate Traps

"The trap should be located a minimum of 12 in. below the heater outlet. This will provide some cooling leg and some static head over the trap to maintain condensate flow. It will also minimize the possibility of holding condensate in the air heaters. In the case of the bottom inlet, inverted bucket traps, the 12 in. minimum would be to the centerline of the horizontal discharge pipe from the trap.

"John Everetts, Jr., of Charles S. Leopold, consulting engineers, has made several excellent suggestions in this regard: 'The distance from the intake of the trap to the bottom of the heater should be 1.25 to 1.50 times the pressure drop through the trap. For example, with ½ psi drop (equivalent head is about 14 in. of water), this would be a distance of 21 in., and for 1 psi drop it would be a distance of 40 in. If space requirements are such that this height cannot be obtained, then the traps must be selected for a lower pressure drop. This will assure sufficient head on the traps to provide the required flow without backing up into the heater where it could freeze.' Inherently this is more easily done with float than with inverted bucket traps.

"Vacuum breakers (equalizers) should always be provided between control valves and air heaters to prevent the formation of vacuums which will hold condensate in the heaters. These should be installed regardless of whether two-position or modulating control valves are provided.

"While the vacuum breakers are provided for the preheaters primarily for freeze protection, they also provide better control by keeping water out of the heaters. This reduces the possibility of hunting. Consequently, the vacuum breakers should also be used for reheaters. Note that the vacuum breaker should be connected to the top of the coil. Also note, that the thermostatic trap in the air vent bypass (Fig. 8) will help to break any vacuums at the condensate end when pressure on the steam header prevents the check valve from opening. With modulating control at some conditions of loading, a vacuum may exist on the condensate side of the distributing tubes even though a positive pressure exists on the header.

"The vacuum breaker at the top of the coil can either be a thermostatic trap or a check valve. It is believed that the small leakage of a check valve is preferable to the uncertainty of a thermostatic trap. The seat angle of the check does not appear to be important, but the 45 deg seat might be preferable.

"Shutoff valves on the steam side of the check are desirable for servicing and for checking leakage. The check valve vacuum breaker and its piping connection to the steam line should be such that water cannot accumulate on either side of the flapper and prevent adequate air passage. For this reason its connection at the heater tee is

preferred. It should be noted that the check valve opens to the steam side."

### Maintain Constant Steam Pressure

In addition to the above precautions, the steam should be supplied from a clean source and at a constant pressure. Where steam pressure fluctuates[3], a pressure reducing valve should be installed in the supply main to assure constant supply pressure.

### Control Considerations

Good practice should be followed in selecting the control components to provide temperature control. Careful sizing of the control valves for a large pressure drop, and the use of parallel control valves when called for in large systems, will promote stable control and freedom from freeze-up. Valves should fail safe so a normally open type valve is recommended.

Control should be provided to close the outside air dampers on fan shutdown and freezestats should be considered in the fan discharge or condensate return to shut the system down in case of trouble. The location of the air freezestat in the fan discharge is preferred because it is better able to sense trouble in this position. Freezestats are no guarantee against freezing, however, because they may not always be able to sense trouble in time to prevent it.

## Freeze Prevention for Hot Water Coils

As noted earlier, the increasing use of hot water for both preheat and reheat in central air conditioning systems has brought about the need for consideration of providing freeze protection for hot water coils. While in the past, a steam preheat coil was invariably installed upstream from the hot water coils, this is being done less frequently as steam often is not available for this service. Consequently, greater freeze hazards exist for the hot water coils in such a system, but even with steam preheat coils, freeze protection for hot water coils cannot be ignored. This is indicated by the results of the survey given in Table 1.

The various considerations in providing freeze protection for hot water coils were presented[4] at the Mechanical Contractors' meeting by G. J. Haufler, J. J. Nesbitt, Inc. Mr. Haufler's remarks are summarized below.

"In considering freeze protection for hot water coils, it is of interest to note the general periods of time during which freeze-ups of hot water coils occur. Although the following percentages are estimated, approximately one-third of all reported freeze-ups occur during the period of installation and temporary heat, another one-third during non-operating hours such as night and weekend periods or breakdowns, and another third during periods of normal equipment operation. While the latter is an extended period of time, and should be most difficult to control, at present it still accounts for only approximately one-third of the total number of hot water freeze-ups. This indicates that even a minimum of attention to the prior two periods will pay great reward."

### Freeze Protection During Installation

"The major part of the problem[4] during installation and temporary heating is awareness of the hazards, and this can be overcome by bearing in mind that freeze-up is a consideration. That is, the contractor must recognize the problem and coordinate work with the subcontractors accordingly. Many failures result from pump shutdown during night or weekend periods, or from isolating a coil or piping zone with hand valves after the system has been filled. Several such cases have been observed in which almost all the equipment on the job has frozen at tremendous expense to the contractor. Briefly, a number of recommendations should be noted which will minimize freeze-ups during installation. These are:

"1) Coordination with the electrical contractor is of utmost importance, and electricians especially should be prohibited from operating fan motors without specific permission.

"2) The piping system should not be filled before the pump is wired and connected, and before heat is available.

"3) Ventilating damper units should not be opened before the controls are finally adjusted. The control contractor should disconnect controls from valves and dampers until a unit or system is in final adjustment.

"4) The system pumps should remain running and the boiler on whenever there is a possibility that the outdoor temperatures may drop below freezing. If this cannot be done, the system should be drained. In the spring and fall this often is overlooked and a weekend drop in temperature has caused severe problems."

While discussing this same subject, J. N. Scanlon, vice president, Kerby Saunders, Inc., suggested two other precautions to observe during construction. This first is to coordinate work with the general contractor so the latter does not leave any openings in the structure through which unexpected and large quantities of outside air may enter the system and expose various components to freezing. The second is to establish clearly with the owner who is responsible for system operation in the transition period during completion of construction and before full occupancy and training of the operating engineer has taken place. With the building partially occupied, the building engineer may unknowingly produce a hazardous condition when he has not been fully instructed in operation of the system.

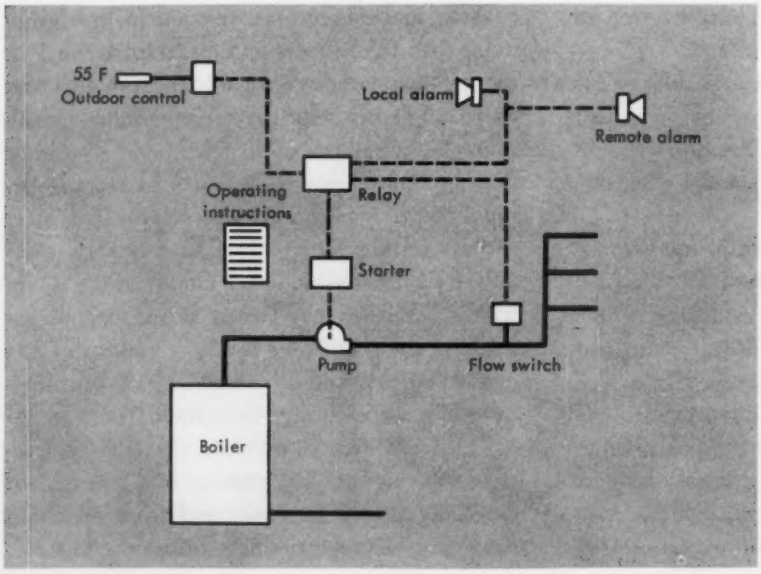
## Freeze Prevention During Shut-down

Noting that the number of freeze-ups during non-operating hours has decreased in recent years, but that they are still too prevalent, Mr. Haufler made the following remarks:[4]

"In general, the causes for these failures are well known, and almost complete safety can be assured by giving design consideration to the problem. The solution may be summarized by the simple statement, 'flow must always be maintained during any period of sub-freezing weather.' This conclusion comes from recognizing that all buildings leak air and lose heat, and that outside dampers may not close tightly.

"Problems during shutdown are primarily associated with automatic pump control and other control considerations, such as control interlocks and night control sequences. The following recommendations have proven to be of importance and will help to minimize freeze-ups during shutdown periods:

"1) The pump must run during all periods when the outside temperature is below 35 F. This is mandatory. While it is preferable to use reset water temperature control, rather than on-off pump operation for maintaining night-time temperature, if on-off operation is used for economy, an automatic over-ride must be provided to




**9** AUTOMATIC PUMP control and surveillance system shown here provides maximum freeze protection for hot water coils by keeping pump running continuously whenever outdoor temperatures approach freezing condition and by alerting operator in event of pump failure

run the pump whenever outside temperatures drop to 35 F.

"2) A flow alarm is recommended to sound warning in the event of a pump failure because of a sheared coupling or motor overload. In areas of frequent power failures, a small standby pump driven by a gas generator is recommended.

"3) Automatic control interlocks should act to exhaust control lines or close dampers in the event of pump failure. Also, no automatic control device should be installed which is capable of stopping the pump, such as a low limit aquastat on the boiler. If it is desired to prevent flow through the boiler until the water is hot, a three-way valve bypass should be provided rather than stopping the pump. In order to insure flow, in addition to continuous pump operation, it is essential that no other device in the system can act to stop flow. In this category, the ordinary control interlocks and night control sequences especially must be considered.

"4) Some device such as an end-point switch must be provided to open the valve as well as close the dampers on fan shutdown. This is of extreme importance, and failure to observe this recommendation has resulted in a large number of past freeze-ups. Night control cycles should be arranged so that the valve *always* remains open and dampers remain closed. The use of zone, night thermostats must be considered with regard to their effect on thermostats or controls in the remote spaces they are controlling."

*Provide Automatic Pump Control*:

A schematic diagram of an automatic pump control arrangement providing maximum freeze protection and surveillance presented[5] by Mr. Crysler is shown in Fig. 9. Mr. Crysler suggested that pump control be tied into the temperature-control specifications for every job. Otherwise, it is likely a pump and pump-starter will be furnished without any freeze protection.

Since the most important point in providing freeze protection is providing continuous pump operation during the entire heating season, an alarm should be provided (See Fig. 9) to sound when the pump stops. A pilot light indicating the pump is running is not enough. Operating instructions should, of course, be permanently posted near the control panel.

Other pump control checks shown in Fig. 9 include outside alarms for unoccupied buildings; a flow indicator independent of the pump circuit; automatic control with no provision for manual operation; pump located to minimize air-binding.

**Checklist of Points to Help Prevent The Hazards of Hot Water Coil Freeze-Ups***

- **Locate all control air piping where it can't freeze.**
- **Don't use room thermostats to prevent freeze-ups.**
- **Oversized valves or valves that hunt add to the freeze-up danger.**
- **Manual control switches should not be used where they have a tendency to increase freeze hazard.**
- **Circulating pump starters should restart automatically after a power failure or low-voltage condition.**
- **Mixed air control of dampers is preferable.**
- **Access doors should be provided for all airstream thermostats to insure proper bulb location.**
- **Temperature controls are not the only safeguard against freeze-ups.**
- **Freeze protection controls that must operate routinely indicate an unsafe system design.**

*From talk prepared by E. C. Hallanger and R. Crysler. See Reference 4, p. 168.

*Control for Safe Night Operation*:

A system with built in safety features for safe night operation is given in Fig. 10 from Mr. Crysler's talk. The principal features as outlined by Mr. Crysler are:

"1) An interlock positively opens the valve when the fan stops (it is essential that the same signal that stops the fan should also open the valve). If the pump is running and water is flowing through the coil, damper leaks such as might occur during shutdown, cannot do any damage.

"2) The freeze protection thermostat, when used, will function only during an emergency such as a pump or boiler failure. Because the low limit is bypassed at night, the valve is always open."

During the discussion following the papers, it was observed that on some occasions with systems controlled as shown in Fig. 10, gravity circulation has brought heated air to viscous filters and has ignited the oil. Mr. Crysler suggested that reset of the hot water control would aid in preventing this problem as well as improving control during normal system operation.

## Protection During Operation

Freeze protection during normal operation can be enhanced by assuring adequate return-outside air mixing, proper control, consideration of coil circuiting and heat transfer relationships, and through the use of other than conventional system arrangements such as unit pumps, ethylene glycol solutions, etc. Ways to provide adequate air mixing have been discussed in an earlier section, the others are discussed below:

*Coil Circuiting*:

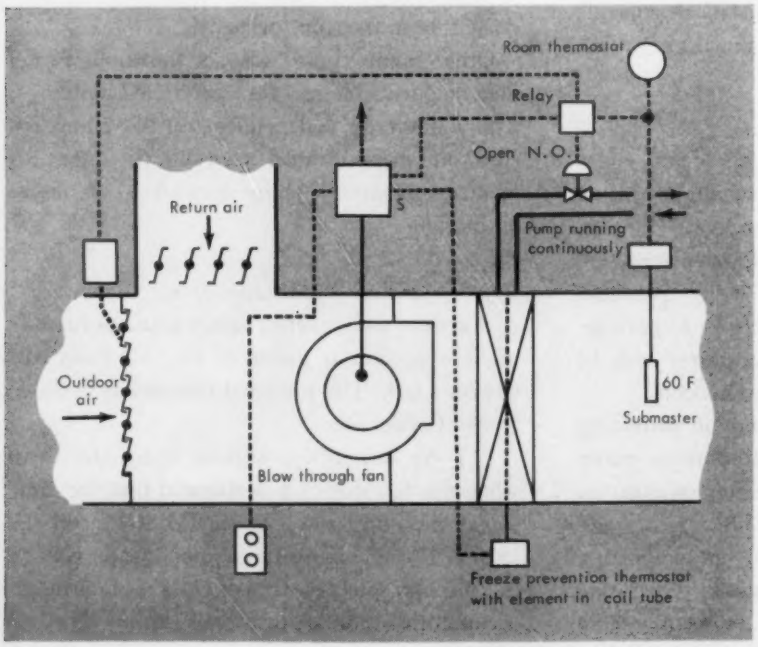
The effect of coil circuiting on freeze protection was discussed[4] by Mr. Haufler. His remarks were as follows:

"Circuiting can have a tremendous bearing on the freeze-up resistance of the coil itself. When heat transfer takes place with air and water in counterflow — the leaving or coldest water in contact with the entering or coldest air — the leaving water temperature as shown in the upper portion of Fig. 11, is dropping in an attempt to approach the entering air temperature. What the leaving water temperature will be in this case depends upon the several factors important in the heat transfer relationships for coils. This is a hazardous situation with large coil depth.

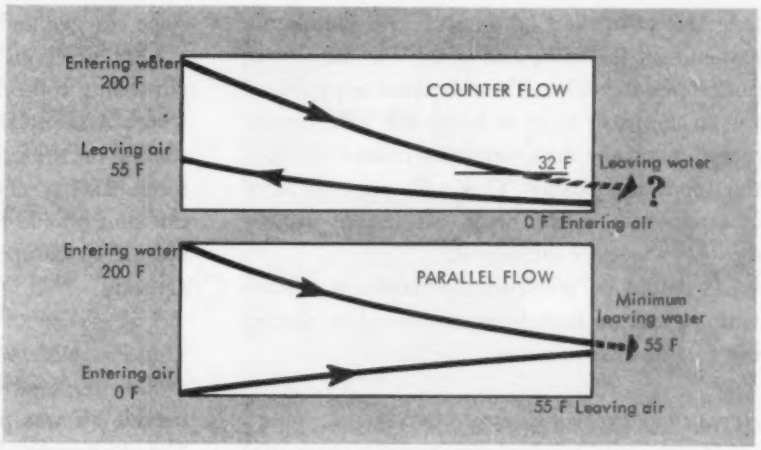
"With parallel flow — the entering or hottest water in contact with the entering or coldest air — it can be seen in Fig. 11 that the leaving water temperature is attempting to approach the leaving air temperature. Since the latter is usually governed by some type of low limit air stream thermostat (usually set at 55 F), the minimum leaving water temperature cannot be below 55 F.

"In consideration of the above, it is recommended that engineers specify and manufacturers rate their coils on the basis of parallel flow installation and that the inlet and outlet locations be marked accordingly.

"It should be noted in passing that counter-




**10** SAFE NIGHT and weekend operation with maximum freeze protection for hot water coils is obtained by control system shown here. Control valve opens whenever fan stops and pump runs continuously. Freeze prevention thermostat with element immersed in coil functions only during emergency such as pump or boiler failure




**11** PARALLEL FLOW water circuiting of hot water coils inherently provides greater freeze protection than counterflow circuiting as shown here. In parallel flow, leaving water approaches leaving air temperature, which is usually controlled at some point above freezing

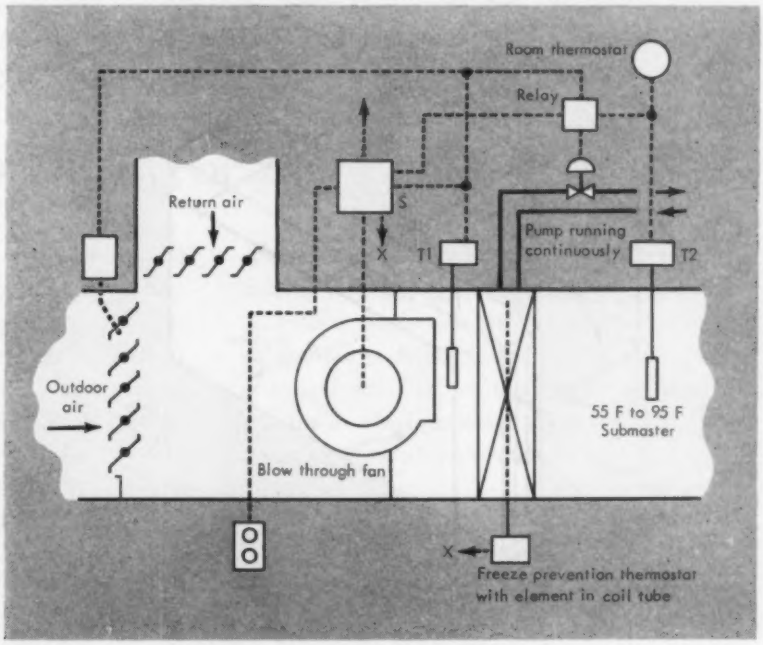
flow arrangements are required for chilled water coils for proper dehumidifying performance. The use of a single coil for both heating and cooling without provision for changeover of flow direction is extremely hazardous because the cooling requirement usually dictates coil sizing and circuiting, and will result in a deep coil in a counterflow arrangement."

*Provide Proper Control*:

Fig. 12 shows the system presented in Fig. 10 during normal or day operation. Mr. Crysler's remarks[5] concerning control were as follows:

"The lower the water temperature supplied from the boiler, the more water has to flow through the coil to satisfy the demands of the temperature controls. If the water is very hot, just a trickle will be called for by the control system. Because of the low velocity and with counterflow circuiting as noted above, the water could be at or near entering air temperature. If freezing air happened to enter the coil near the last rows of tubes, this could mean freeze-up.

"Another freeze hazard is caused by unstable control action. With a combination of too hot water, oversized valves, and oversized pumps, it is possible for the submaster or low limit controller to hunt. If the hunt period is sufficiently




**12** NORMAL OPERATION of system in Fig. 10 is illustrated here. Submaster prevents valve closure by adjustment of room thermostat. Water temperature is reset to assure maximum flow at any outdoor temperature condition. Freezestat T1 stops fan and closes dampers if freezing air is discharged by fan

long, freeze-up can occur after the thermostat has shut off the valve and before the thermostat can reopen the valve. The submaster is preferred for large spaces since it keeps the valve under control from the duct controller instead of from the room thermostat. This will prevent valve closure which might occur because of adjustments of the space thermostat.

"It should be noted that problems associated with air mixing have been minimized by placing the coil downstream from the fan.

*Avoid these Preheat Control Methods*:

"Water coils selected for preheat using 100 percent outdoor air present a special problem. One method of providing freeze protection — which has proven unsatisfactory — is the use of a fixed bypass around the control valve which assures a minimum flow of water to the coil. The bypass method is not satisfactory because:

"1) Even a small flow of water going through the coil will overheat the building or room in mild weather.

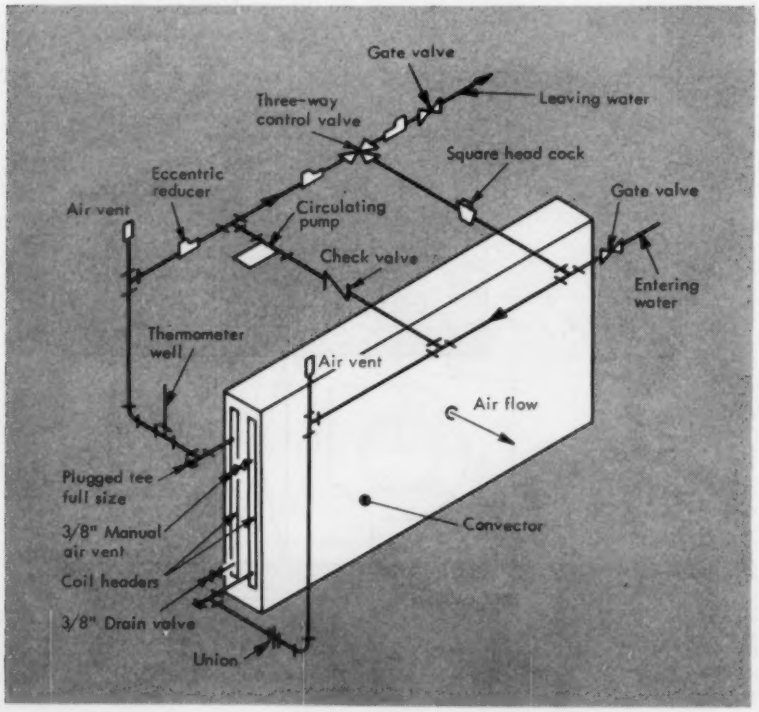
"2) If the flow is reduced to the point where the room will not overheat, the flow will be so small that the bypass will almost certainly become clogged and inoperative after a short time.

"Another poor solution is to use straight proportioning control of an outside air preheat coil where a safety control stops the fan when air coming off the coil approaches freezing temperatures. This is not good because the thermostat can shut off the valve: then the tightness of the outside air damper is the only protection against freezing."

*Unit Pump Method for Preheat*:

A better solution for using hot water to heat outside air was presented in a recent article[9] by S. I. Rottmayer, Samuel R. Lewis & Associates. A schematic diagram of the piping arrangement used by Mr. Rottmayer in what is frequently called the "unit pump" method is shown in Fig. 13. In this system, the circulator keeps water flowing through the coil continuously with enough hot supply water admitted to the circuit to maintain the required discharge air temperature. The three-way valve is controlled to respond either to room temperature or the discharge air temperature. As noted above, control by a submaster in the discharge air is preferable.

Safety controls not shown in Fig. 13 but em-




**13** UNIT PUMP arrangement illustrated here provides freeze protection for hot water coils used to heat 100 percent outdoor air. Pump assures constant circulation of water through coil. Additional freeze protection controls not shown which should be considered include a freezestat in the air downstream from the coil, a flow control, and a freezestat in the leaving water

ployed by Mr. Rottmayer include: control to close outside air intake dampers on fan shutdown, and a freezestat in the air downstream from the coil. Others which should be considered include: an aquastat in the water leaving the coil to stop the fan and close the outside air dampers at some preset minimum water temperature, and a flow control to provide the same function in the event the unit pump fails. However, as noted[10] by Mr. Rottmayer, judicious use of safety controls should be made, with the knowledge that:

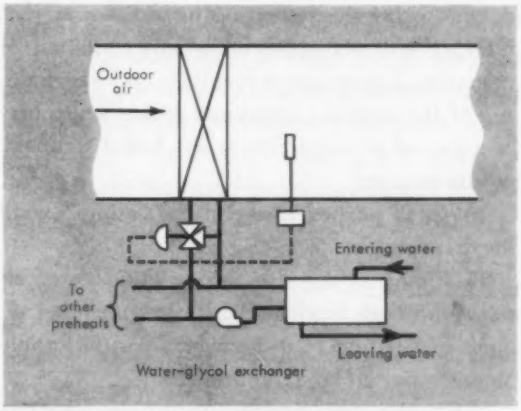
"1) The investment costs must be weighed against the expected returns.

"2) Such controls, in themselves, are not infallible.

"3) A false sense of security may follow the use of multiple safety controls, resulting in abandoning the vigilant supervision that is due any mechanical equipment by the operating personnel."

*Ethylene Glycol-Water Systems*:

Another method suggested[5] by Mr. Crysler for heating outside air is with a water-to-glycol heat exchanger such as is shown in Fig. 14. In this system, an ethylene glycol-water solution is circulated through the preheaters. This system, it was pointed out, may be more economical in the long run than the various safety controls and alarms necessary with water even though the heat exchanger and extra pump must be provided. This is especially true if several preheaters can be supplied from a single glycol heat exchanger. Freeze protection must still be given some consideration in this arrangement too. Freeze-ups of the water-to-glycol heat exchanger have been experienced when the flow of hot water has been interrupted and the glycol-water solution permitted to circulate and the fan continued to move air at sub-freezing temperatures through the preheat coils. Design and installation considerations for systems employing ethylene glycol-water solutions were presented[11] in the HPAC Engineering Data File, "How to Prevent Failures in Radiant Heating and Snow Melting Systems."




**14** ETHYLENE GLYCOL-WATER solutions in secondary heat exchange system as shown here provide maximum protection for hot water coils used to heat 100 percent outdoor air. Properties of ethylene glycol-water solutions must be considered in design and installation to assure satisfactory performance. Freeze protection should be considered for water-glycol exchanger to stop fan and close outdoor air damper whenever flow of hot water is interrupted

# Freeze Protection For Idle Cooling Coils

Providing freeze protection for idle chilled water coils is increasing in importance because of increased internal loads (lighting, office machines, etc.) and increased desire on the part of tenants and owners to obtain uniform temperatures year around. To do this, cooling may be required on a warm January day even in northern climates. To be prepared to provide this service, the cooling system must be in a constant state of readiness as time usually is not available to fill drained coils.

Notwithstanding the above remarks, cooling systems can be divided into two categories requiring different approaches to providing freeze protection. These are systems in which mechanical cooling is definitely not required for three or four and possibly five months of the year, and systems in which cooling may be required whenever the outside temperature exceeds 55 to 60 F.

## Systems Which Can Be Laid Up

When a system will not be called upon to provide cooling for several months, it is good eco-

nomics to lay the system up in such a way that freezing will not occur under any condition of operation. Lay up simply requires *complete* draining of the coils and associated piping which may be exposed to sub-freezing air. Good drainage in turn requires:

1) Coils pitched down in the casing toward the drain cocks.

2) Piping arranged to insure drainage of all tubes and both headers. This may sometimes require installation of a drain between the supply shutoff valve and the coil header.

While the above is considered to be adequate by most coil manufacturers, evidence exists that for one reason or another coils do not always drain completely (See Table 1).

To overcome this, two methods of attack can be used:

1) After draining, the coil can be blown with low pressure air (40 psi). This may have to be repeated several times to completely dry the coil because the water may be vaporized and recondense in the tubes. High pressure air should not be used as it increases the problem of vaporization and may damage the coil, controls, etc.

2) A better solution is to flush the coil by pumping a concentrated solution of ethylene glycol through it to pick up residual moisture. This will result in a *safe* water-glycol solution in any pockets in the coil which may hold water. The anti-freeze can be used repeatedly for flushing out coils, but its concentration must be checked periodically to insure that it will provide the degree of protection required. Through repeated usage, the initial solution will be diluted and the freezing point will increase, thus reducing the protection offered by using it.

## Systems for Year Around Cooling

Freeze protection for idle chilled water coils. which can provide cooling on demand and, thus, must be filled year around, has been accomplished in a variety of ways. Freezing may be caused by poor air mixing and stratification, or by mechanical failure of the preheat system. Published information on this subject is limited, but experience reported at the Mechanical Contractors' convention provides a base for exploring the subject in more detail. Two methods will be considered here; namely, the use of ethylene glycol-water mixtures in the entire chilled water piping system, and chilled water pump operation as a method of freeze protection.

## Use Pump to Prevent Freeze-ups

Operation of the chilled water pumps has provided apparent freedom from freeze-ups of idle chilled water coils. This method was reported[12] in 1953 by W. A. Stahl and at the Mechanical Contractors' convention by W. J. Abraham[13] and others. It was noted also that this method is very popular in the upper New York area. Although pump operation is apparently successful, reliance should not be placed on pump operation to prevent freeze-ups unless design consideration is given to the factors involved. Some that must be considered are coil circuiting, water velocity, air velocity, and other variables related to the heat transfer between the moving air and the water in the coil.

To examine qualitatively the effect of each of these, engineering estimates were made of the minimum entering air temperature that would produce a minimum leaving water temperature of 33 F in one pass of a finned tube coil. The assumption was made that an average leaving water temperature of 33 F will preclude ice formation in the coils. Actually, a layer of ice may form where local tube temperatures are below 32 F. This will tend to increase the pump head, but decrease heat transfer because of the reduction in flow and reduced inside surface area. Thus, it is assumed that these factors balance one another and safe operation results.

The coil selected for this evaluation was a finned chilled water coil with $\frac{5}{8}$ in. O.D. copper tubes. Estimates were made for a single tube pass but the results apply to a coil of any height. The minimum entering air temperatures were determined by a trial and error solution with the knowledge that the heat loss from the water, the heat gain to the air, and the overall heat transfer based on manufacturer's data must be equal when steady state exists.

It was also assumed that water at 65 F would be supplied continuously to the coil by the sys-

tem pump. The volume of the system, duration of hazardous freezing conditions, and heat transfer *to* the water in other coils in the system and the piping, would determine whether 65 F water could be supplied for sufficient time to provide freeze protection.

A summary of the calculations is given in Figs. 15 and 16. The following observations can be made:

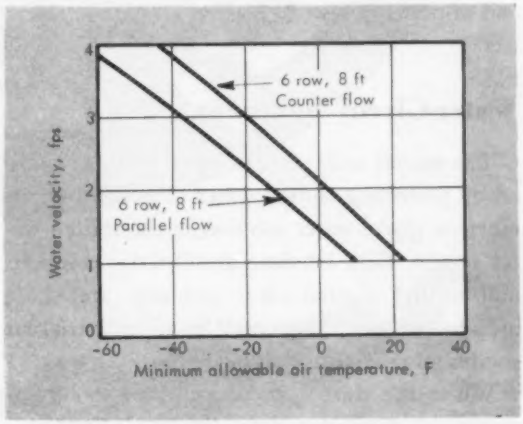
1) As water velocity is decreased (See Fig. 15) — usually for reasons of economy to reduce pump operating costs — decreased freeze protection results. Although it might be assumed that reduced water velocity, because of reduced heat transfer, would give greater protection, the decrease in the energy available in the water per unit time decreases at a greater rate. Consequently, providing freeze protection by operation of the system pump at reduced speed or by operating only one of a number of pumps in parallel to minimize pump operating costs should be done with due caution.

2) Parallel circuiting of chilled water coils during the winter by a suitable piping arrangement (Fig. 15) will provide increased protection at a given water velocity or reduce the required velocity and, therefore, the pump head for any desired protection temperature.

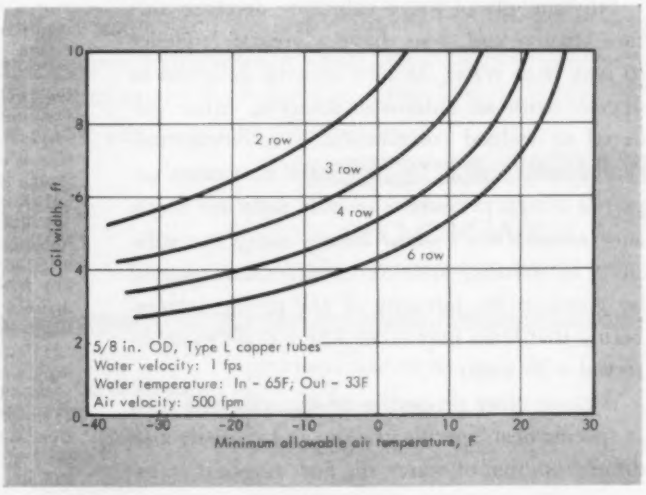
3) Increases in coil width and coil depth (number of rows) will decrease the protection provided at given water and air velocities (Fig. 16). For example, a 6-row coil, 10 ft wide will be protected for entering air temperatures of about 27 F, but a 6-row coil 4 ft wide will be protected to about −3 F. It should be noted that Fig. 16 is for a counterflow circuiting arrangement. With parallelflow, the trends would be the same but the curves would shift to the left to indicate increased freeze protection for this method of circuiting.

4) Increased air velocity, because it increases heat transfer, will also raise the minimum air temperature which can be tolerated.

In short, anything that increases the heat transfer in the coil from the water, or decreases the heat delivered to the coil by the water in unit




**15** IDLE CHILLED WATER coils can be protected from freezing by running chilled water system pumps but protection achieved depends upon water velocity and coil circuiting as shown here for coil with ⅝ in. O.D. copper tubes. Other conditions assumed in calculating curves were: air velocity of 500 fpm, entering water temperature of 65 F, and leaving water temperature of 33 F




**16** COIL FACE WIDTH and depth affect amount of freeze protection that can be obtained for idle chilled water coils by pump operation as shown here. Counterflow circuiting of the coils was assumed in calculating these curves. Trends would be same with parallel flow but curves would shift to left indicating greater protection for given coil and flow conditions

time, will increase the freeze-up hazard.

In his talk at the Mechanical Contractors' convention, W. J. Abraham, operating engineer. The Merchandise Mart, suggested[13] the following preventive operating procedures related to the use of pump operation for freeze protection of chilled water coils:

"1) Operate chilled water pumps when the outside temperature drops below 35 F.

"2) In fan rooms where stratification is apparent, attempt to eliminate the stratification.

"3) When the outside temperature is below freezing, operate all systems with the chilled water valves *wide* open.

"4) When temperatures are below 20 F, start and stop all fan systems locally."

## Water-Glycol Solutions

The second and, perhaps more positive, method of protecting chilled water coils is to use an ethylene glycol-water solution in the chilled water system. Both ethylene glycol-water solutions and methyl alcohol-water solutions are being used by one plant engineer[14] in all industrial air conditioning systems that he designs.

While the use of these antifreeze solutions causes no particular difficulty in new systems when taken into consideration in design and installation, some properties of the solutions make application in existing systems difficult. The principal considerations are the leak tendency of the ethylene glycol-water solutions, and properties which tend to reduce heat transfer.

Ethylene glycol-water solutions decrease surface tension and, thus, have a greater tendency to leak than water. In new systems designed to operate with an antifreeze solution, either soldered or welded construction is recommended. A hydraulic test at 1½ times the maximum expected design pressure is usually sufficient to assure a leak-free system. Before using the solutions in existing systems, consideration should be given to the integrity of the piping remembering that leaks may occur where none were observed with water.

Because other properties of the solutions such as specific heat, specific gravity, and viscosity also differ from that of water, the flow and heat transfer characteristics of an existing system must be evaluated before attempting to use the solutions for freeze protection. In new systems, these can be compensated for in design. In general, the effect is to increase[11] the physical size of pumps, heat exchange equipment, and piping. Thus, the additional cost must be weighed against the cost of providing protection by continuous pump operation and assuming a reasonable incidence of freeze-ups.

Ethylene glycol-water solutions can be corrosive and must be suitably inhibited. Depletion of the inhibitor takes place gradually during operation and periodic checks of its quality must be made. This can be done on a scheduled basis with other water treatment checks. If attention is given to maintaining the solution, the corrosion problem is no greater than it is with water.

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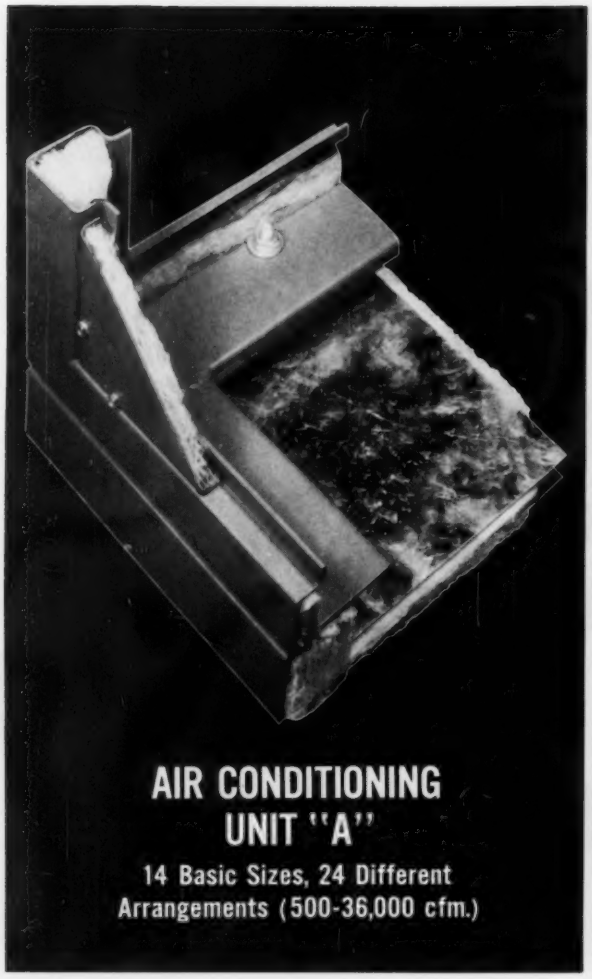

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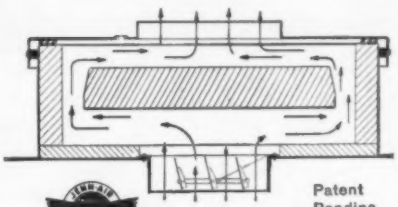


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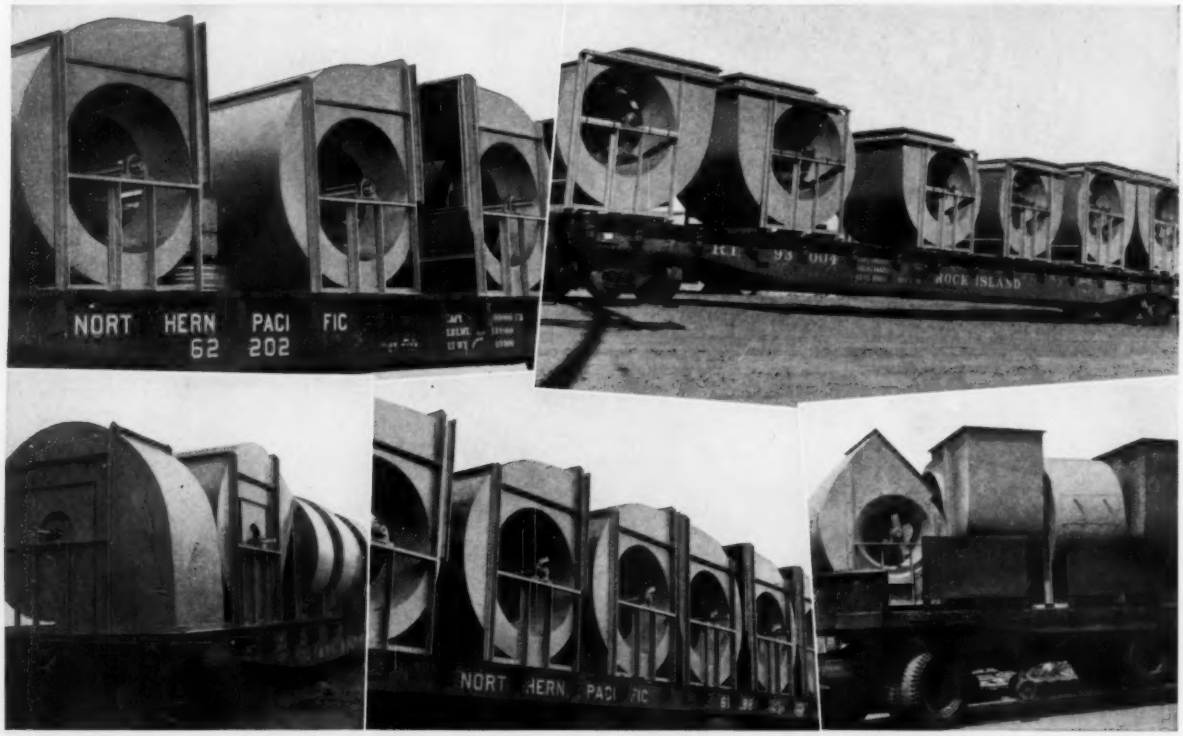


# BARRY

## centrifugal fans are engineered to do the job *RIGHT!*

Yes, big air moving jobs can bring big headaches . . . unless your blower supplier can give you fast delivery on fans that will do the job right. That's where Barry's experience pays off for you!

Barry builds a lot of big fans, and Barry's know-how assures you of speedy delivery on every big blower project. And the same inherent precision, good design, perfect balance and overall attention that regularly goes into our smaller fans will also be found in our larger units.

Whenever you require big volume fan equipment—see your Barry representative. And even if your fan needs are not as large as the blowers shown here, your Barry representative can help you solve all your problems quickly and efficiently!

***fast delivery too!—on fans in all classes from I to IV:—***
***check with BARRY first, you'll save time and money!***

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# extra economy

✓ for the contractor
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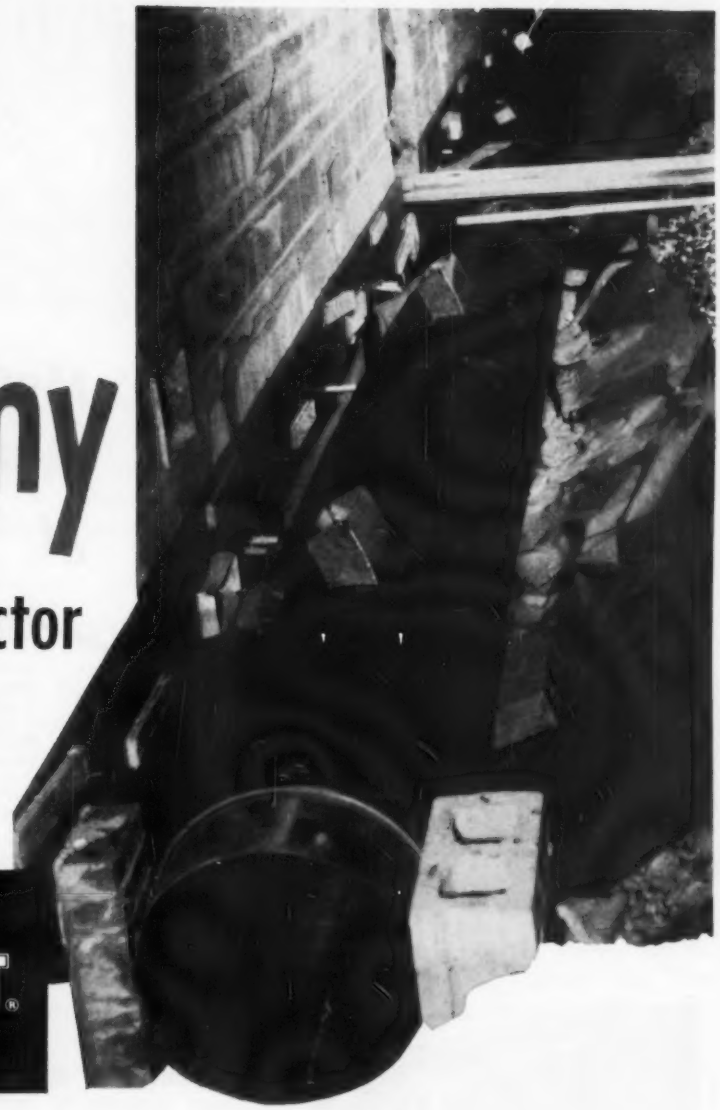

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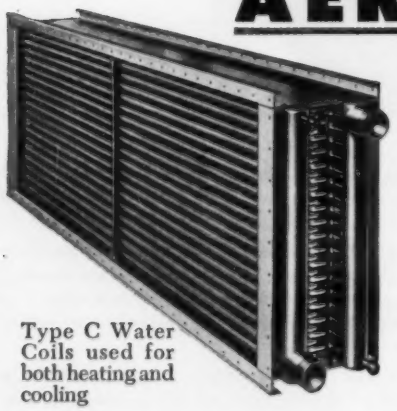

Type C Water Coils used for both heating and cooling

Modern smooth-fin design of Aerofin coils permits ample heat-exchange capacity in limited space—permits the use of high velocities without turbulence or excessive resistance.

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More than 300 hot water reheat coils throughout the building provide zone heating

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# EQUIPMENT DEVELOPMENTS

### Packaged Boiler Produces Up to 2,009,000 Btu Per Hr

Three-pass, low pressure unit has rated output from 355,000 through 2,009,000 Btu per hr, or 10.6 through 60 hp. Available in 12 sizes. Handles primary and secondary gas on a separate basis, producing a high $CO_2$. Comes in two sections for installation in the field: a one-piece boiler and a one-piece burner-base assembly. Designed for 15 psi steam or 30 psi water and is hydrostatically tested at 60 psi. Information sent on request. — *Iron Fireman Manufacturing Co., 3299 W. 106th St., Cleveland 11, Ohio.*

### Power Gas Burners Have High Capacities

Units available in two types: model "L" units, with square wind boxes, have a capacity range of from 350,000 to 6,000,000 Btu per hr; model "K" units have a flange-mounted, cylindrical burner box with built-in refractory face and capacities from 200,000 to 6,000,000 Btu per hr. — *Mid-Continent Metal Products Co., 2717 N. Greenview Ave., Chicago 14, Ill.*

### Cabinet Unit Heaters Available in 136 Models

Units available in 17 types with eight sizes in each type. Includes free-standing units, models for mounting on walls or ceilings, and for recessed installations. Feature optional push-button lubrication systems that send metered amounts of lubricant to every oiling point. Available with either automatic or manual controls for use with hot water or steam systems. With the use of optional equipment, units can be used to ventilate with outside air. Air delivery capacities range from 250 to 2000 cfm. — *Modine Manufacturing Co., 1500 DeKoven Ave., Racine, Wis.*

### Hermetic Condensing Units Range from 20 to 60 Tons

Units for use in field assembled air conditioning equipment. Consists of a water-cooled condenser, a hermetic compressor, and a control center. Suction operating temperatures from 20 to 50 F are standard. Starters, safety controls, gage panel, and all internal control and power wiring between control center and compressor are standard. Motor protected against overheating. Compressor is equipped with quick-trip overload relays for protection against excessive instantaneous motor currents, — *Westinghouse Electric Corp., P.O. Box 2278, Pittsburgh 30, Pa.*

### Roof Mounted Air Conditioners In 7½, 10, and 15 Ton Models

Units for cooling, heating, or year around air conditioning available in 7½, 10, and 15 ton models. Can be used in combination for higher capacities. Heating units use natural, mixed, or propane gas. Heat exchangers can be placed upstream or downstream of the cooling coil. — *Chrysler Corp., Airtemp Div., 1600 Webster St., Dayton 4, Ohio.*

**INFORMATION** on capacities, dimensions, applications, and special features in each **EQUIPMENT DEVELOPMENT** item is presented in accordance with material furnished by the manufacturers, who may be contacted directly for more details.

***Other Departments . . .***


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**We Hear That . . . . . .228**

**Meetings and Conventions . . . . . 234**

**New Books and Reports . . . . . .240**

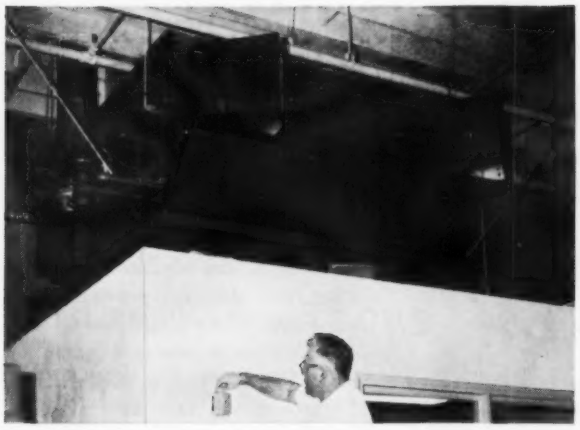
## another *LENNOX* installation

# Provides a "clean, fresh atmosphere" with extreme simplicity and economy

*"The versatility of the equipment permits us to completely ventilate our manufacturing area and provides a clean, fresh atmosphere for our employees. We are convinced that the Lennox direct-fired system has many advantages over the conventional small unit heater system. We are enjoying these benefits."*—Maintenance Supt., Kraloy-Chemtrol Co., a subsidiary of Rexall Drug & Chemical Co., Santa Ana, Calif.

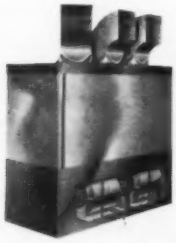
Whether the job calls for heating, air conditioning, make-up air, ventilation, process work—or a combination, Lennox offers a complete line of warm air heating and air conditioning equipment—from one manufacturer. Direct-fired industrial heaters with up to 2 million Btuh capacities, and air conditioning equipment for every size of installation are all designed, tested and manufactured in our own factories. You deal with one company, represented by one man who is a professional heating and air conditioning technician. He relieves you of details and red tape—has the right equipment on the job when you need it. For complete information on Lennox industrial heating and air conditioning equipment, write LENNOX, 620 S. 12th Ave., Marshalltown, Iowa, or phone your nearest Lennox office.

*LENNOX: A SINGLE SOURCE FOR HEATING, VENTILATING, AIR CONDITIONING*



5 Lennox units used to heat and ventilate this large Kraloy-Chemtrol plastics plant

This big open plant utilizes five horizontally-mounted, large capacity gas-fired heaters. The units are strategically located around the perimeter of the building, with individual thermostats providing finger-tip regulation of temperature. Each of the units heats and ventilates approximately 25,000 square feet of floor area. Fresh air louvers are installed in the outside walls to provide additional ventilation in the summertime. The heater fans pickup outdoor air and discharge it through the discharge nozzles to provide spot cooling. Outside exhaust stacks don't extend above the roof line due to induced draft equipment. Compact design and trouble-free operation have helped reduce maintenance costs—as in all Lennox industrial installations.



Lennox can heat, cool and ventilate any existing building

The complete line of Lennox equipment, and your Lennox representative will not only make your buying or designing job easier, but will give you an integrated heating and air conditioning system.

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## EQUIPMENT DEVELOPMENTS

*Continued*

### Solenoid Valve For Cryogenic Service

Midget packless type two-way solenoid valve for handling cryogenic liquids and gases. Controls flows from −100 F to temperatures approaching absolute zero. Supplied in either brass or stainless steel with "Teflon" discs and gaskets. Can be mounted in any position. Send for form No. V5126. — *Automatic Switch Co., Florham Park, N.J.*

### Gas-Fired Unit Heaters Available in Nine Sizes

Suspended gas-fired unit heaters available in nine sizes from 25,000 to 225,000 Btu per hr capacities. Aluminized steel heat exchanger has high temperature and corrosion resistance. Units are approved by the AGA and CGA for use with natural, mixed, manufactured, or propane gas. — *Mueller Climatrol, Div. of Worthington Corp., 2005 W. Oklahoma Ave., Milwaukee 1, Wis.*

### Unit Combines Negative Ion Generator With Electrostatic Air Filtration

Negative ion generator and electrostatic air cleaner combined in a single unit for industrial, commercial, and institutional applications. Filters pollens, dust, allergens, bacteria, and smog particles, removing up to 97 percent of the foreign matter from the air. — *Elotec Corp., 1425 N. Lidcombe St., El Monte, Calif.*

### Cooling Tower Capacities Range Upwards from 100 Tons

Lightweight steel "CompacTowers" have curtain-wall casing, honeycomb segments in filling, air intake and air discharge areas, and design of cold water basin to minimize weight. All internal areas are readily accessible for inspection and maintenance through conveniently located access panels. Available in all-metal, fire-proof models. Send for bulletin CT-61. — *The Marley Co., 222 W. Gregory, Kansas City, Mo.*

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## EQUIPMENT DEVELOPMENTS
*Continued*

### Surface Condensers Cover 200 to 10,000 Sq Ft Range

Single bank, balanced flow surface condensers cover a range of 200 to 10,000 sq ft, and are built to specification from standard, pre-engineered components. Particularly adaptable to small turbine drives and pump or blower drives. Shell diameters from 15 through 48 in.; any practical tube length; two tube sizes: $\frac{5}{8}$ and $\frac{3}{4}$ in.; one, two, or four pass arrangements; and six water box design presures: 30 through 300 psi. Shell and tube sides are designed for working temperatures of 150 F. Shells are reinforced to withstand operation under full 30 in. Hg vacuum or 15 psig pressure. — *American Standard Industrial Div., Detroit 32, Mich.*

### Centrifugal Roof Ventilator Has Low Silhouette Design

Unit features straight-line styling and low compact shape. Has extruded aluminum discharge vanes. Exhaust is directed horizontally. Models range from $\frac{1}{8}$ to 5 hp with wheel diameters from 0.99 to 3 ft. Heights range as low as $11\frac{1}{2}$ in. Information sent on request. — *Western Engineering & Manufacturing Co., P.O. Box 66455, Los Angeles 66, Calif.*

### High Pressure Immersion Steam Boilers From 10 to 100 Hp

Boilers in nine sizes ranging from 10 to 100 hp for working pressures of 150 psi. Complete enclosure of the blower and conducting air supply to the intake through a silencing duct in the combustion assembly removes resonance at the blower inlet. Units are insulated and steel jacketed. Send for brochure No. 6000. — *Sellers Engineering Co., 4876 N. Clark St., Chicago 40, Ill.*

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## makes a three count pledge to customers

•You can be sure of getting fast service on any of Waterloo's wide range line of grilles and registers. Though we'll meet your requirements in a hurry, quality will never suffer.

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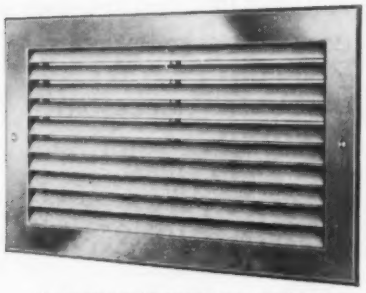
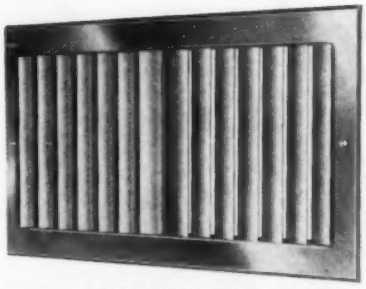
•You can count on the fact that Waterloo prices are competitive.

## WATERLOO offers a complete line

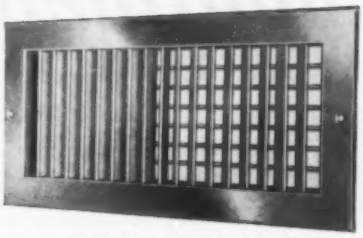
TYPICAL WATERLOO UNITS:



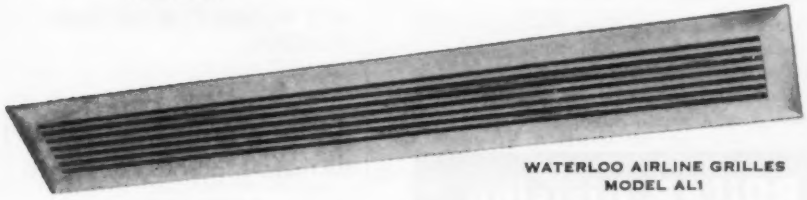
WATERLOO RETURN AIR GRILLES
AND REGISTERS
MODEL 3HD



WATERLOO CURVED LOUVER GRILLES
MODEL 1CV2



WATERLOO SUPPLY GRILLES
MODEL 2V



WATERLOO AIRLINE GRILLES
MODEL AL1

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*Air Diffusion*
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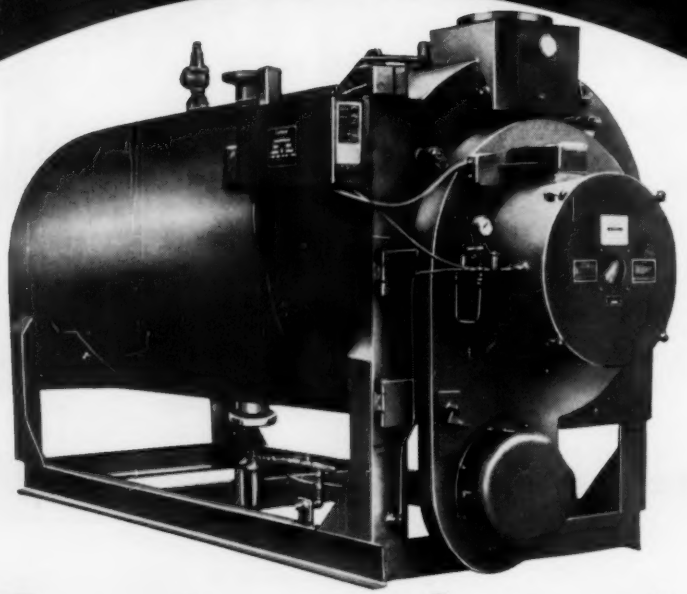

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Continental Boilers in hot water service have established an outstanding performance record—*no* failures or damage from thermal shock have occurred among *all* units in service. Low, medium and high temperature operation is included in various system designs and under widely varying seasonal conditions. This proven performance has resulted in Continental Boilers being approved and specified in ever-increasing numbers by design engineers.

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*Continued*

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Units in three models: a direct connected type "PQ" in six sizes from 12 to 36 in. fan diameter, delivering 1235 to 10,860 cfm under free air conditions for application where extremely quiet operation is desired; a direct connected type "PD" in five sizes from 24 to 48 in. fan diameter, delivering 4700 to 32,200 cfm of free air for industrial use to exhaust smoke, dust, and fumes, or as circulators and man coolers; and a belt-driven, heavy duty, slow speed type "PB" in sizes of 42, 48, and 60 in. fan diameters, delivering 14,320 to 52,700 cfm of air. — *Propellair Div., Robbins & Myers, Inc.*, 1345 *Lagonda Ave., Springfield, Ohio.*

### Motor Valves For Fan-Coil Units

Two and three-way motor valves control the flow of hot or chilled water in fan-coil units and other applications. Units made of forged brass will operate in any position. Compact size facilitates mounting in coil housings. A simplified valve-tubing connection speeds installation. Information sent on request. — *Erie Manufacturing Co.*, 4000 *S. 13th St., Milwaukee* 21, *Wis.*

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Either model converts to an efficient boiler feed unit by adding a solenoid-operated make-up valve.

Weinman Condensate Return Units are rated up to 65,000 sq. ft. EDR at 60 psi. For complete information write for Bulletins 900 and 910 or call your Weinman pump specialist. He's in the Yellow Pages.

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## EQUIPMENT DEVELOPMENTS

*Continued*

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Units for air conditioning or industrial process applications. Requires less than 8 sq ft of space and are slightly more than 4 ft high. Tube in tube evaporator and condenser coils made of admiralty brass to protect against corrosive water conditions. An alternate model for air cooled installations is supplied without the water cooled condenser and may be hooked directly to an external air cooled condenser. Available with either capillary refrigerant feeding systems or thermal expansion valves, the chillers operate on either 220 or 440 voltage. — *Typhoon Heat Pump Div., Hupp Corp., P.O. Box* 1123, *Tampa, Fla.*

### Gas Burner Sections For Make-Up Air Systems

Gas-fired burner sections are equipped with controls and control panels wired and piped for installation. Can be arranged for horizontal or vertical mounting, with nine sizes from 1,875,000 to 6,000,000 Btu per hr. Fan capacities, when furnished with burner sections, range from 20,000 to 60,000 cfm. Accessories include: shutdown damper sections (motor operated), wall intake louvers, louver towers, roof hood intakes, door heat seals, discharge nozzles, and angle filter banks. — *Metals Engineering & Manufacturing Co., Inc.,* 8824 *Lyndon, Detroit* 38, *Mich.*

### Minimum-Friction Bearing Uses Air as Lubricant

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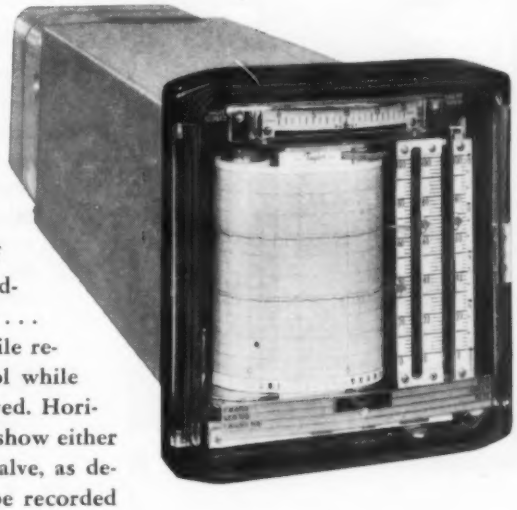
**Let Taylor solve your measurement or control problems. Ask your Taylor Field Engineer or write for literature. Taylor Instrument Companies, Rochester, N.Y., and Toronto, Ontario.**



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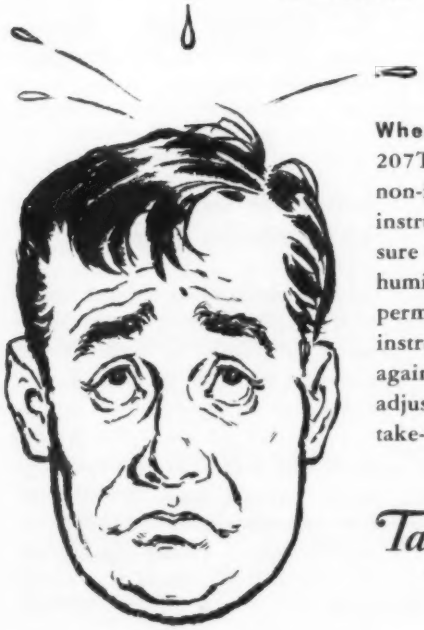

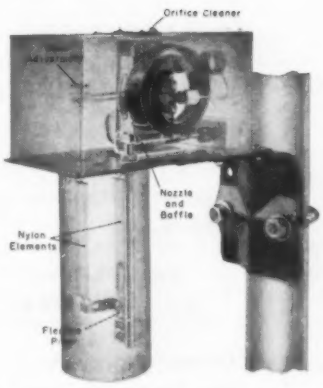


**When Transmission Is Necessary** Taylor 207T Relative Humidity Transmitter is a non-indicating, pneumatic, motion-balance instrument. It produces an air output pressure (3-15 psi) proportional to the relative humidity around the sensing elements, permitting a direct reading in the receiving instrument. Zero setting can be checked against wet and dry bulb hygrometer—adjusted with knurled nut on Bourdon spring take-off arm.

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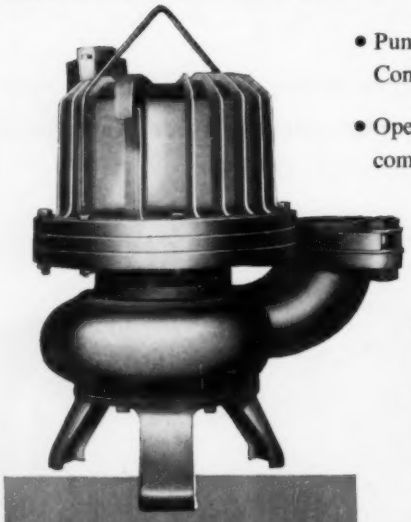

- Pumps Sewage and other Liquids Containing Solids up to 2½"
- Operates with pump and motor completely submerged

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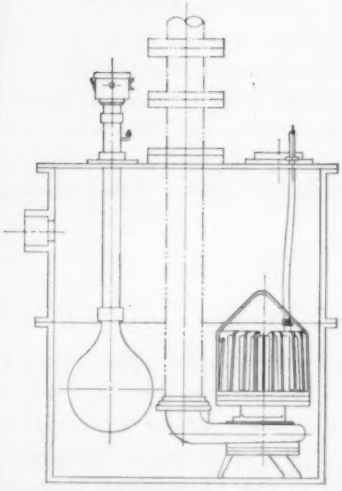
2. Low maintenance cost
3. Easy to install
4. Easy to service
5. No superstructures required
6. Minimum headroom needed
7. Makes more floor space available

*Positively water proof—motor is totally enclosed and oil filled.*

**PLUS**

Exclusive SEALTRODE Sealed Electrode Floatless Pump Controller . . . the only controller featuring completely sealed Electrodes . . . positively preventing insulation or coating by grease or other corrosive elements.

**Ask for Bulletins Nos. 97 and 128-A.**



Typical installation—single unit—duplex installation available

**"Chicago" Distributors are located in most principal cities. See the one nearest you today for full details.**

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FOOD MACHINERY AND CHEMICAL CORPORATION

HYDRODYNAMICS DIVISION

**CHICAGO PUMP**

622C DIVERSEY PARKWAY • CHICAGO 14, ILLINOIS

## EQUIPMENT DEVELOPMENTS

*Continued*

### Ball Valve Seats Provide Shutoff in Event of Fire

Ball valves have seats that provide tight shutoff of flammable or dangerous fluids in event of fire. Consists of a primary seat of metal-encaged reinforced "Teflon" which incorporates a machined secondary metallic seating surface. If "Teflon" is destroyed by excessive heat, metal to metal contact between ball and secondary seat shuts off flow. Top-entry and bar stock valves made of carbon steel. Stainless steel and other materials also available. Information sent on request. — *Hills-McCanna Co., 400 Maple Ave., Carpentersville, Ill.*

### Air Cooled Condensers Rated from 20 to 60 Tons

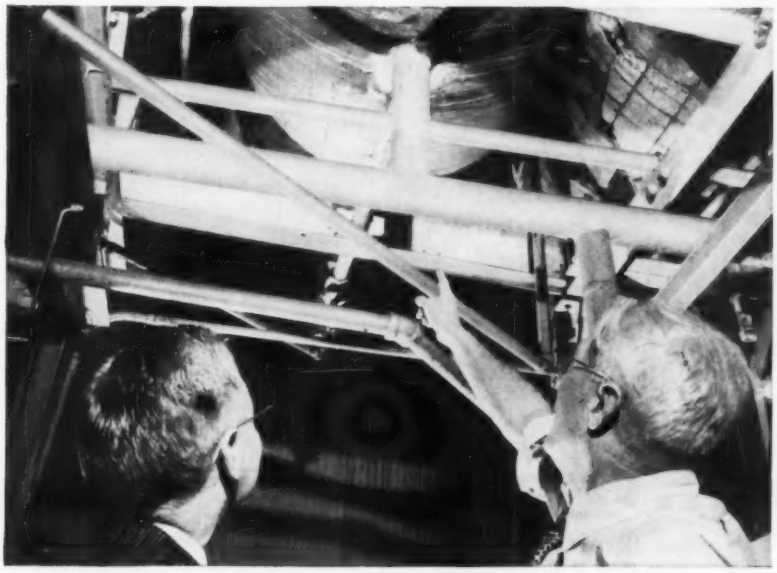
Air cooled condensers for horizontal or vertical air flow. Designed for either roof top or ground level installation. Available in ratings from 20 to 60 tons. Coil design makes possible a low refrigerant charge requirement. Slow speed propeller fans of the nonoverloading type are belt driven by a single dripproof, grease-lubricated motor. Send for bulletin 2232. — *Westinghouse Electric Corp., P.O. Box 2278, Pittsburgh 30, Pa.*

### Ceiling Tile Serves as Air Distribution System

Foil-backed ceiling tile permits air to enter room from a plenum space above the ceiling. Air supply within a desired sector of the room is controlled by adjustable slides on the back surface of each tile. Adjustments can be made from below. Kept under constant static pressure, air flows through all slot openings at the same velocity. — *United States Gypsum Co., 300 W. Adams St., Chicago 6, Ill.*

# BYERS GUIDE

**Tips on How to Minimize Corrosion Costs from A. M. Byers Co.** VOL. 2, NO. 6



R. W. Williamson, Plant Engineer (left), and William Slack, Master Mechanic for Columbia Steel & Shafting Company, Carnegie, Pa., examine a 4-inch Wrought Iron feedwater line running from the make up tanks to the feed pump and into the boiler.

## Wrought Iron Condensate Return Lines Save 18 Replacement Jobs in 6 Years

When R. N. Williamson, Plant Engineer at Columbia Steel and Shafting Company, decided to install Wrought Iron condensate return lines, he saved himself eighteen replacement jobs in the six years the Wrought Iron piping has been installed. Steel pipe previously used failed on the average of every three to four months, pushing maintenance costs completely out of line.

Six years ago, Mr. Williamson discussed this problem with Byers engineers, and decided to install Byers Wrought Iron pipe. As of today, there have been no failures in the condensate return system, and of course, no maintenance costs, for which Mr. Williamson is very much pleased.

In this plant, steam is used for both heating and pickling. Three 250 hp gas-fired boilers supply 18,000 pounds of steam per hour. Condensate is returned to the boiler at pressures of 55 to 60 psi. Due to the varying pH of the condensate, the system had a real corrosion problem, but the use of Wrought Iron piping has it well under control.

Byers 4-D Wrought Iron pipe has a built-in corrosion resistance that stands up to the most difficult jobs. Why not find out how Byers can save you time and money—use the coupon.

## Heating, Air Conditioning Lines—Corrosion Target

Steam heating plants are particularly subject to corrosive attack. In such areas as condensate return lines, steam lines and even fuel oil lines, the very nature of the material carried makes chemical protection of the lines difficult—in some cases, impossible. Here Byers 4-D Wrought Iron pipe's ability to stand up to corrosion can save far more than the original cost of the system.

The unique composition of Wrought Iron is responsible for its selection as a *permanent* piping material. It is a two-component metal, made up of high-purity iron and glass-like fibers or iron silicate. There are approximately 250,000 fibers per square inch of Wrought Iron. They bar the spreading of rust through the base metal. For complete information on the application of Wrought Iron to heating and air conditioning systems, use the coupon.

## The Odds Are Five to One—You Can't Afford to Lose

SERVICE LIFE is the key to true piping economy. And nothing proves this so completely as contrasting installation costs with repair costs. This is especially true where piping is concealed—One man can install it, but if it has to be repaired, *five* men may be required—the pipe fitter, a carpenter, a mason, a plasterer and a painter. When you look at long term costs, the use of materials that will resist corrosion makes sense. Even short term costs can be reduced by this kind of preventive maintenance. Facts and figures on Byers 4-D Wrought Iron are yours for the asking—use the coupon.

**A. M. BYERS COMPANY**

**PIPE PRODUCTS:** Wrought Iron • PVC • Steel
**ROLLED PRODUCTS:** Plates, Billets and Bars • Wrought Iron, Stainless and Alloy Steel

A. M. Byers Company, Clark Building, Pittsburgh 22, Pa.

Please send data on items checked: ☐ Steam Condensate Report

☐ Piping for Permanence ☐ True Piping Economy

Name _____ Title _____

Company _____

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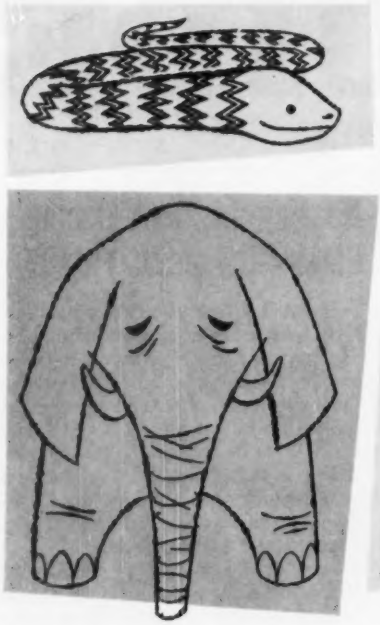

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## EQUIPMENT DEVELOPMENTS

*Continued*

### Top Entry Ball Valves Have One-Piece Bodies

Ball valves have one-piece bodies made of cadmium-plated carbon steel or stainless steel bar stock. Threaded inlet and outlet connectors permit installation in 3/8, 1/2, 3/4, and 1 in. lines. Maximum pressure-temperature ratings are 150 psi at 365 F for steam lines, and 1000 psi for water, oil, liquid chemical and gas-handling applications. Ball is made of hard chrome-plated bronze or stainless steel, resting between seals of Buna N synthetic rubber or "Teflon." — *Strong, Carlisle & Hammond,* 508 *Sandusky St., Conneaut, Ohio.*

### Diaphragm Pump for Corrosive Chemical Additives

Electrically driven pump for service with sulphuric acid and other corrosive chemicals used as water additives. Capacity about 1 gpm against pressures to 100 psi. Diaphragm type unit offers self priming and air purging, and has a dial-adjustable feed rate control. A single phase, 60 cycle, 115 v motor operates pump at a speed of 30 strokes per min. Unit weighs 8 lb. — *The Bird-Archer Co.,* 4337 *N. American St., Philadelphia* 40, *Pa.*

### Slide Rule Eases Task Of Sizing Control Valves

Slide rule for sizing control valves for known conditions of flow, pressure, etc. Solves for $C_v$ and corrects for steam quality, gas specific gravity and temperatures, and liquid specific gravity and viscosity. Standard slide rule scales A, B, C, and D are also incorporated. Step-by-step instructions are provided. Rule will be sent on request. — *Fulton Sylphon Div., Robertshaw-Fulton Controls Co., P.O. Box* 400, *Knoxville* 1, *Tenn.*

# COMING... NEXT MONTH!

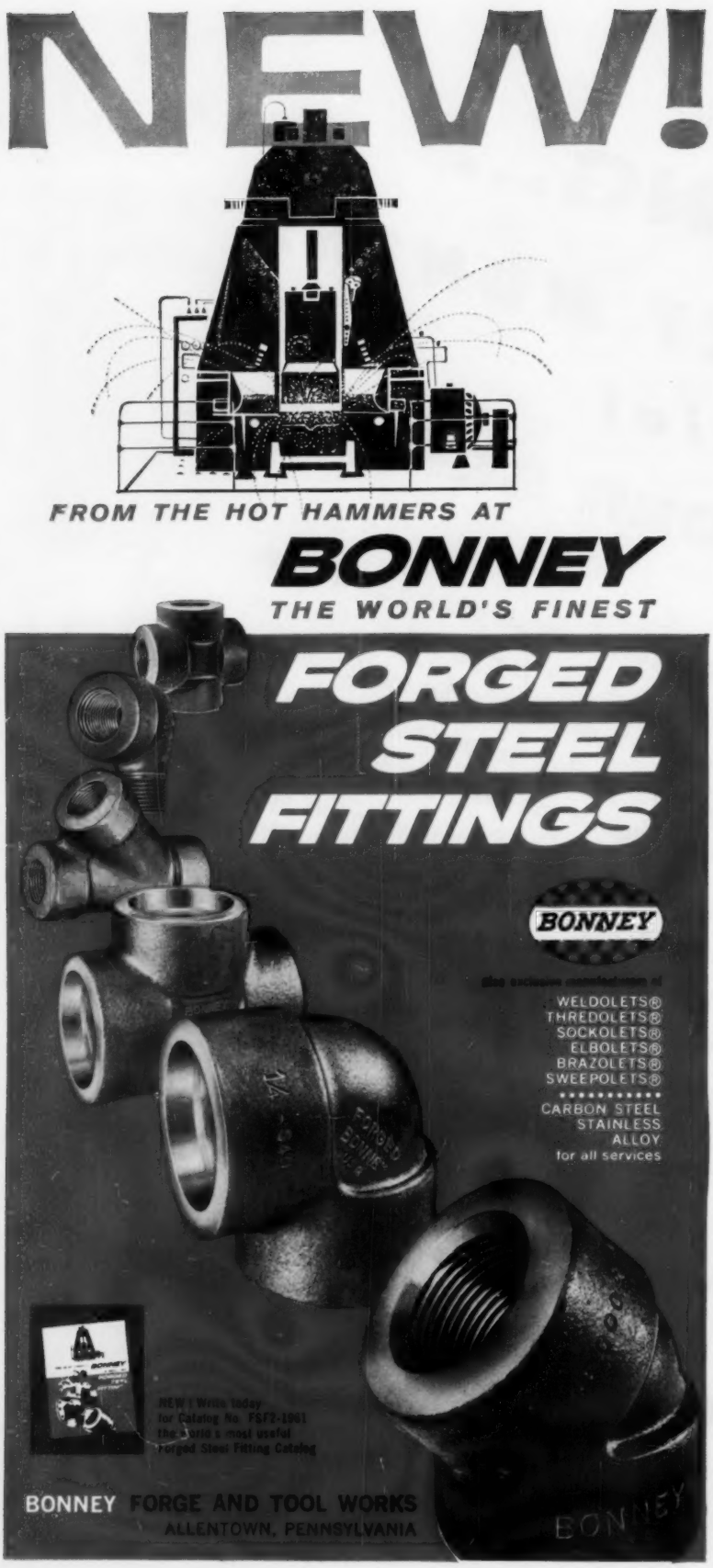
## A special READER SERVICE

Heating, Piping & Air Conditioning will publish a special "Trade Literature Supplement" as part 2 of its August 1961 issue. This "Trade Literature Supplement" will list and describe catalogs, bulletins and other data that advertisers wish to make available to our engineer and contractor subscribers.

This Supplement will be mailed to subscribers right with the magazine in August. It will list and number each piece of literature and include reply cards for the convenience of subscribers in requesting copies of the information in which they are interested. The Publisher will pass these requests on to the manufacturer who will in turn supply the literature to the person requesting it.

You are invited to use this special service in acquiring helpful data.

**HEATING, PIPING & AIR CONDITIONING**
**6 North Michigan Avenue**
**Chicago 2, Illinois**




## EQUIPMENT DEVELOPMENTS

*Continued*

### Chemical Feeder for Unpressurized Water Systems

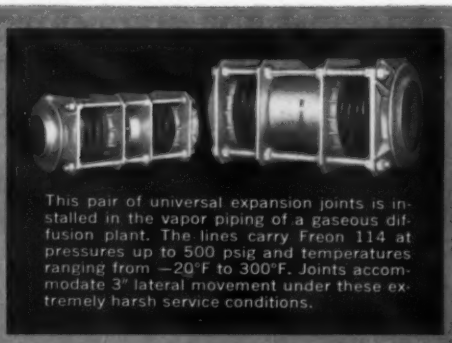
Unit for pumping chemical treatment into cooling towers, evaporative condensers, or other unpressurized water systems to control and prevent development of algae and other bacteriological formations. Low-friction, unbreakable "Teflon" stopcock does not require lubrication or move under vibration. Flow control valve permits ¾ gpm at line pressures up to 125 psi. Check valve prevents backflow into chemicals. Has no moving parts; requires no maintanance. Send for literature. — *California Scientific Glass Co., 9811 E. Rush St., El Monte, Calif.*

### Motor Starter for Air Conditioning Applications

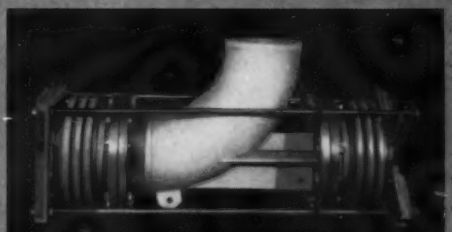
Reduced voltage autotransformer for use in air conditioning applications is a size 6 controller, and is 90 in. high, 36 in. wide, and 28 in. deep. Contactors are rated 600 v, 600 amp for either front or rear connection and are mounted on a steel panel. Information sent on request. — *Westinghouse Electric Corp., P.O. Box 2278, Pittsburgh 30, Pa.*

### Cabinet Blowers Have Capacities to 15,000 Cfm

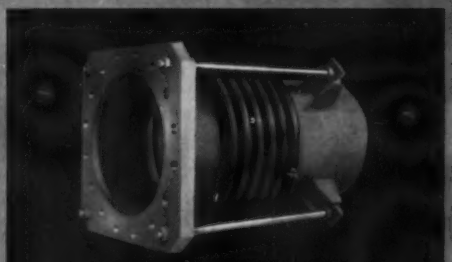
Single blower models have capacities from 2000 to 9000 cfm; double blower models have 4000 to 15,000 cfm capacities. Designed to match firm's gas-fired duct furnaces. Matching filter cases available for use as independent sections or as companion sections of the blowers. Cabinets are made of heavy gage steel and are vibration free. Supension or base mounting of units are simplified by use of threaded mounting pipes. — *Reznor Manufacturing Co., Mercer, Pa.*



This pair of universal expansion joints is installed in the vapor piping of a gaseous diffusion plant. The lines carry Freon 114 at pressures up to 500 psig and temperatures ranging from −20°F to 300°F. Joints accommodate 3" lateral movement under these extremely harsh service conditions.



A 12" pressure balanced elbow assembly specially engineered by Badger for use in LOX storage and transfer facilities at an Air Force Missile Base. The unit is designed to operate at temperatures from −297°F to 250°F — a thermal shock range of nearly 550°! Operating pressures vary from 0 to 150 psig. Joint movement: 0.8" axial, 0.15" lateral.



One of eight specially engineered Badger Expansion Joints at a power plant for a gas recovery unit in Texas. Installation is on a cooling water piping of the surface condensers where service conditions require operation at 55 psig at a temperature of 107°F. The joints are designed to absorb ½" lateral movement in combination with ¼" axial movement.

This 24" x 44½" I.D. rectangular expansion joint, connects the turbine and condenser at a steam power plant. Each of the units is designed to operate at a pressure ranging from full vacuum to 1 psig at a temperature of 360°F. The joint handles ⅜" axial compression and a plus or minus ⅛" lateral movement.

# TOUGH JOINTS

## — BADGER SPECIALTY

Anyone with the necessary manufacturing facilities can fabricate expansion joints. But it takes an *experienced* manufacturer to analyze tough piping problems properly and then provide the correct expansion joints to solve them. Badger, with more than 55 years in the field, has had more experience with a wider variety of special design problems than any other expansion joint manufacturer. Put this store of skill and knowledge to work for you — get the most effective and economical solution to your expansion joint problem. Call or write for complete information about Badger S-R Expansion Joints and our "on-the-spot" engineering service.

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230 BENT STREET, CAMBRIDGE 41, MASSACHUSETTS

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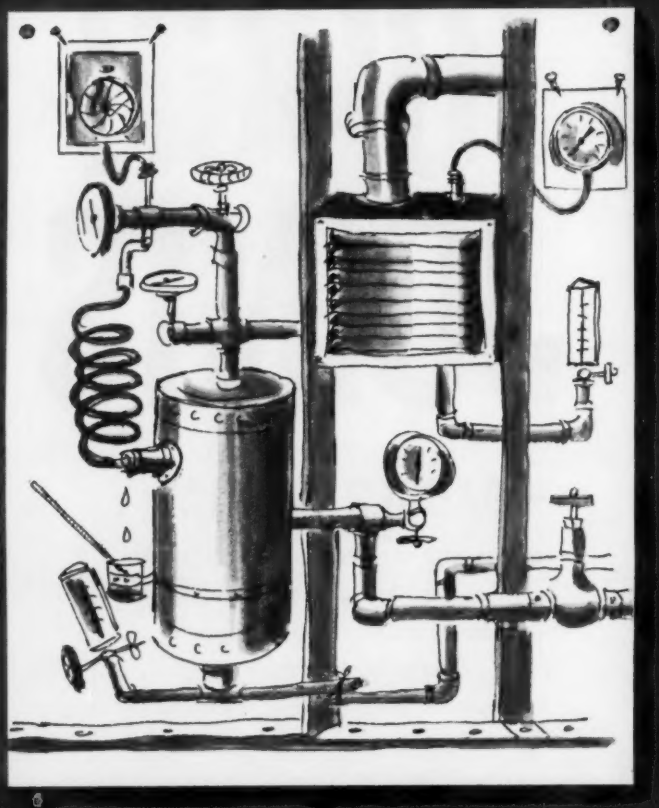
# SEARCHING FOR A "SPECIAL"_____?



## DOLLARS TO DOUGHNUTS IT'S STANDARD AT WEKSLER!

Why the confidence? We have manufactured literally *MILLIONS* of different types of instruments for measuring and recording temperature, pressure, humidity and time-of-operation. More than likely, the special you're looking for has been produced by *Weksler*. At worst, your problem will prove routine for our engineers.

Save hours, money and a lot of headaches by consulting us *first*. Other manufacturer's *"Specials"* are probably *Standard* with Weksler.

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**WEKSLER INSTRUMENTS**
CORPORATION
195 EAST MERRICK ROAD, FREEPORT, L. I., N. Y.
Indicating, Recording, and Controlling Instruments for Temperature, Pressure and Humidity


## EQUIPMENT DEVELOPMENTS
*Continued*

### Plastic Pressure Pipe for Pressures to 100 Psi at 250 F

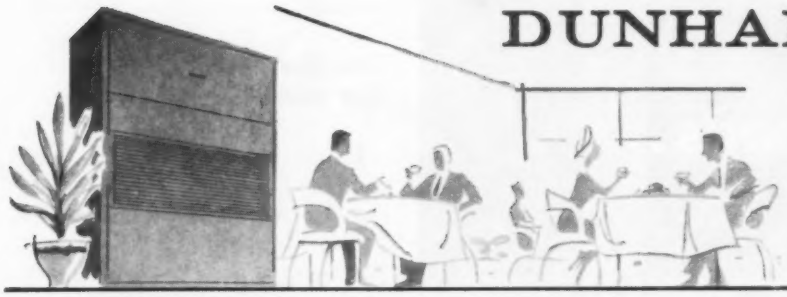
Corrosion proof reinforced plastic pressure pipe capable of withstanding pressures up to 100 psi at temperatures as high as 250 F. Available in 10 and 20 ft lengths and furnished in glass fiber and cloth construction. Wall thickness ranges from ¼ to ⅝ in., depending on pressure and temperature requirements. "Duracor" pipe suitable for above ground or under ground installation. Fittings and field joining kits also available. Send for data sheets and information. — *The Ceilcote Co., 4967 Ridge Rd., Cleveland 9, Ohio.*

### Small Induction Motors Have Two Mounting Styles

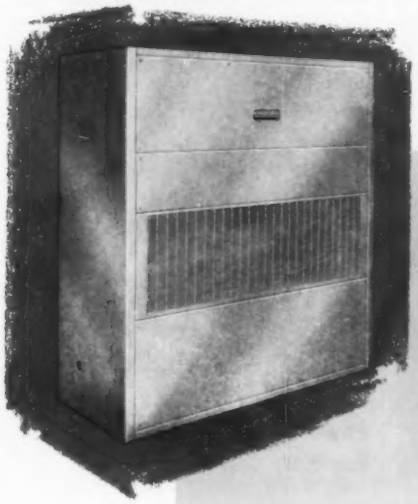
Small induction motors with 3⅞ in. diameter have solid bases and four boss end-mountings. Available in two-pole designs through 1/3 hp and through ⅛ hp in four-pole single-phase designs in both horizontal and all-angle sleeve bearing, open motors. Totally enclosed, ball-bearings, and reluctance synchronous motors also available. — *General Electric Co., Schenectady 5, N.Y.*

### Modular Duct Furnaces Rated Up To 350,000 Btu Per Hr

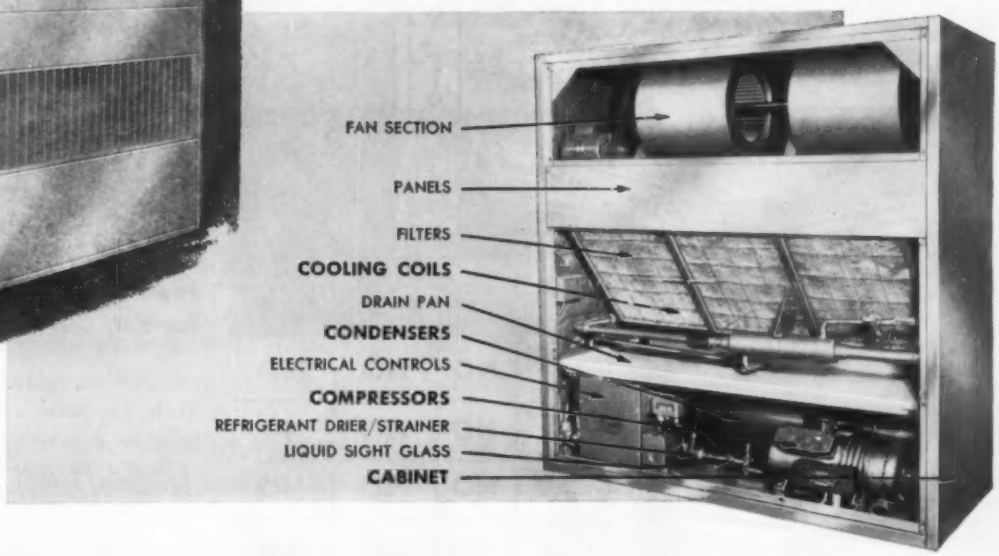
Units rated from 150,000 to 350,000 Btu per hr input. Eight sizes available. Standard models approved by the AGA for installation downstream from cooling coils in year around air conditioning systems. Approved for temperature rises ranging from 20 to 100 F. Modulating input ranges down to 20 percent. Equipped with condensation shields for burner protection, hooded pilots, and drain pans with drain connections. — *Reznor Manufacturing Co., Mercer, Pa.*



# DUNHAM-BUSH 'PAC'



## Proves how to properly package air conditioning




Important to contractors and specifiers is peak performance of Dunham-Bush "PAC" Packaged Air Conditioners, achieved through pre-engineered major components. Other manufacturers, using components from diverse sources, must attempt to improvise balance. But Dunham-Bush manufactures and designs the motor compressor, condenser, evaporative coils and cabinet specifically for "PAC". This "one source-one responsibility" is evident in dependable operation and customer satisfaction.

"PAC" units are packaged for use, on-premises or remotely installed, in restaurants, stores, offices, clubs, banks, factories, depots or wherever high capacity, self-contained air conditioning units are required. Attractive finish harmonizes with decor practically anywhere.

"PAC" is available in 10, 15, 20, 25 and 30 h.p. capacities with either front or top discharge Air cooled or Water cooled models.

You'll want to have full details. Write today for Bulletin No. 6022 or request a copy from your nearby Dunham-Bush representative.

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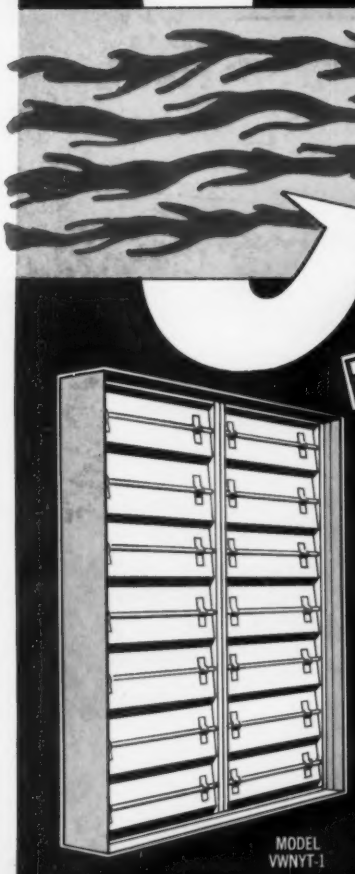
FIRE TRAPPED

*before it spreads...*

WHY?



MODEL VWNYT-1

| FEATURES | U.L. 1½ HOUR TESTS* | U.L. FACTORY INSPECTIONS | APPROVAL BY BOARD OF STANDARDS & APPEALS, N.Y.C. |
|---|---|---|---|
| Competitor X | NO | NO | NO |
| Competitor Y | NO | NO | NO |
| Competitor Z | NO | NO | NO |
| IMPERIAL MODEL VWNYT-1 | YES | YES | YES |

A Multi-Blade Fire Damper now produced under the factory inspection and label service of the Underwriters Laboratories Incorporated. ***SPECIFY*** **IMPERIAL #VWNYT-1 FIRE DAMPERS.**

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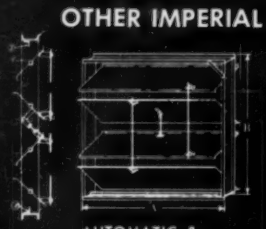

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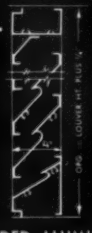

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## EQUIPMENT DEVELOPMENTS

*Continued*

### Tank Heaters Have Cast Steel Headers

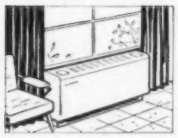
Heavy duty tank heaters have cast steel headers that provide high corrosion protection. Outlet header has a concave bottom that serves as a trap to collect steam condensate; allows quick drainage. Fintubes are 1½ in. IPS Schedule 80 seamless pipe, with 36 fins per in. permanently bonded to tube. Rapid heat flow from tube to fin causes thermal siphon action in the tank and prevents stratification or sedimentation. Pressure rating (based on 1/16 in. corrosion allowance): 600 psi at 650 F. Send for bulletin 300. — *Brown Fintube Co., 300 Huron St., Elyria, Ohio.*

### Power Roof Ventilators For Hot, Corrosive Air

Belt-driven units for installations where hot, moist, corrosive, or fume-laden air is exhausted. Motor mounted in a weatherproof housing outside the air stream. Available in 20 sizes and free air capacities from 2000 to 60,500 cfm. Capacities at ½ in. SP range from 1350 to 53,000 cfm. — *L. J. Wing Manufacturing Co., 2300 N. Stiles St., Linden, N.J.*

### Condensate Return System For Cooling and Heating

System for use with air conditioning units used in connection with one-pipe steam radiation. Designed for new and existing high and low rise apartment buildings. In summer, condensate pump removes condensate as it is formed and returns it to steam pipe system. Also includes a thermostatic trap: a water receiving chamber with a float mechanism inside, and a motor. Operation is automatic. — *Air-X Industries, Inc., 1210 Randall Ave., Bronx, New York.*



**Floor mounted**

**Horizontal**

**Between studs**

# ...THERE'S A CARRIER FAN-COIL UNIT FOR EVERY APPLICATION!

**Complete assortment of factory-fabricated cabinets. Also base units and accessories for custom furred-in applications.**

**Shaded pole motors are standard. Permanent split capacity motors available for lower operating cost.**

**Quiet operation assured by heavy insulation and low maximum motor speeds.**

**User may select low fan speed for ultra-quiet performance.**

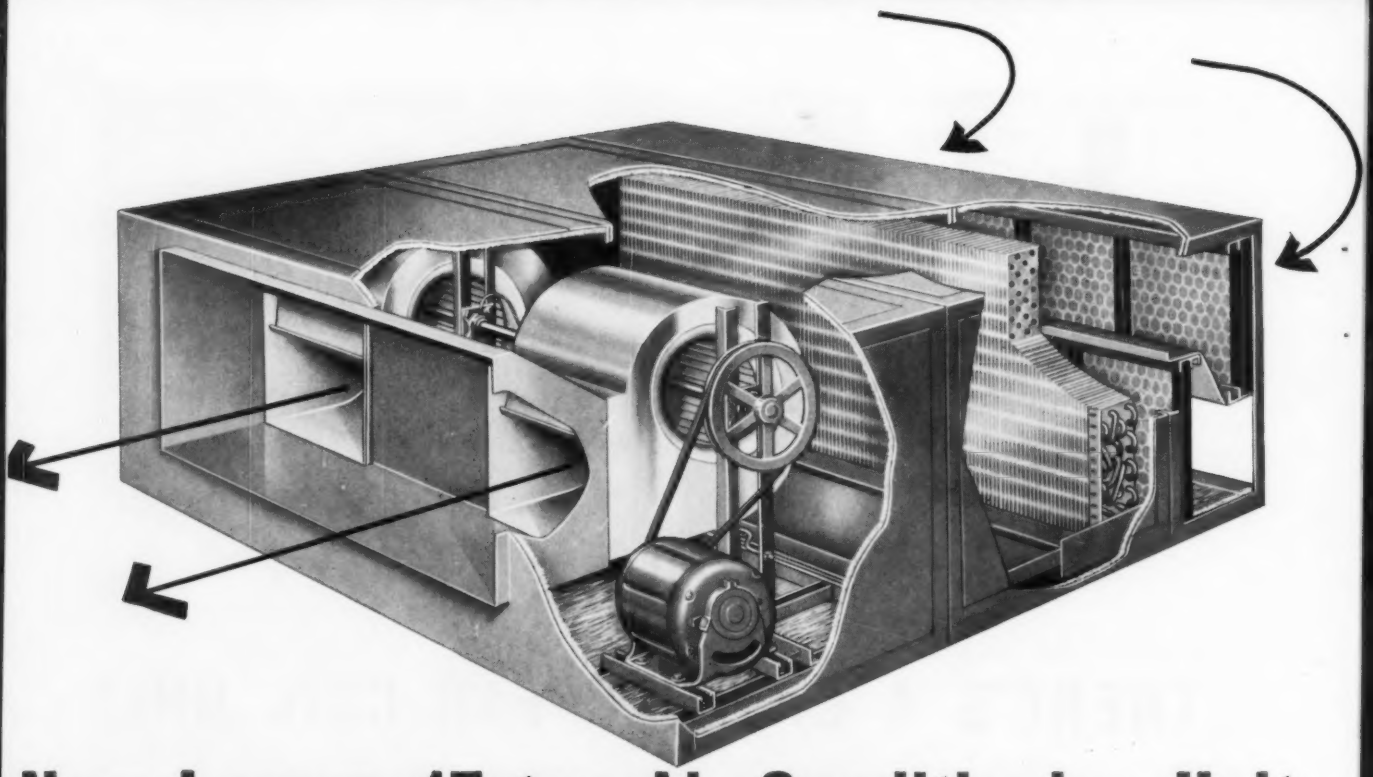
Carrier offers a *complete* selection of Fan-Coil Weathermakers* to provide climate a la carte for individual rooms. They are proving particularly popular in apartments and motels because they permit excellent user flexibility yet centralize the water chilling and heating apparatus.

Complete selection? Consider control versatility alone. The floor mounted model offers a choice of 17 different control arrangements... the horizontal model a selection of 11—including manual or automatic fan control and manual, self-contained, electric or pneumatic water control.

For information about the entire Carrier Fan-Coil line, write Carrier Air Conditioning Company, Syracuse 1, New York. In Canada: Carrier Air Conditioning Company Ltd., Toronto.

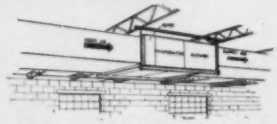
*Reg. U.S. Pat. Off.

**Carrier Air Conditioning Company**



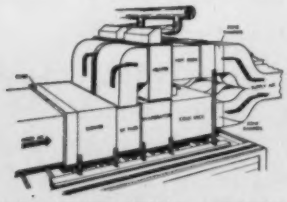
# New Lennox 17-ton Air Conditioning Unit

**EASILY ADAPTS TO WARM AIR HEATING**
**... room in cabinet for hot water or steam coils**

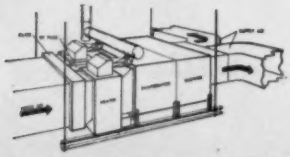


COOLING SYSTEM ONLY
(or with wet heat coil added)

ANOTHER COOLING APPLICATION



COOLING, VENTILATING, HEATING WITH DIRECT-FIRED HEATER
(multi-zone)



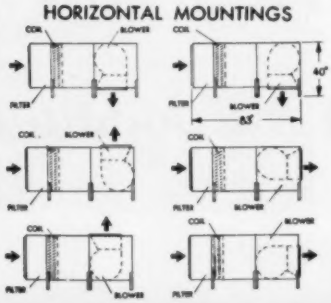
COOLING, VENTILATING, HEATING WITH DIRECT-FIRED HEATER
(single-zone)

## A "jillion" possibilities for up-flow, down-flow or horizontal application

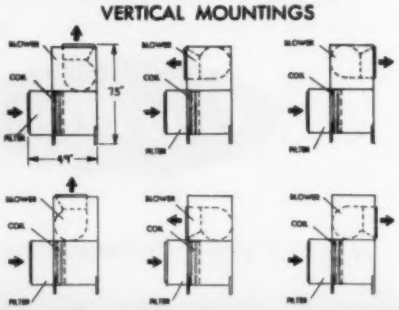
You've asked for it and here it is! Never before has so much cooling been put in such a compact package. And, a unique dual refrigerant circuit gives you latent capacity control without using expensive by-pass ducts or complicated control systems. A simple two-stage controller does the job, providing modulated temperature and humidity control. The ample face area of the coil reduces total resistance in the system. Result: lower BHP.

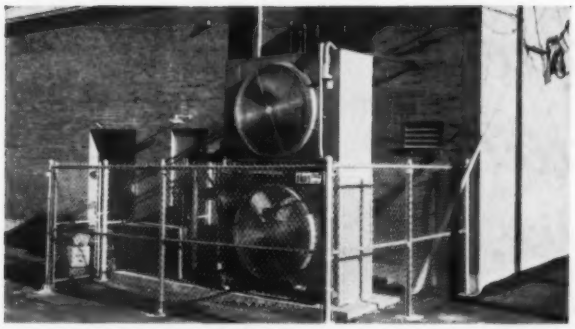
The unit consists of three sections: evaporator, blower, and filter. They are easily assembled for horizontal, up or down air delivery. Motor and plumbing are enclosed in the cabinet which is weatherproof and lined with 1-inch fiberglass. Recessed blower outlets permit duct connection without additional transitions. All servicing can be handled from one side. For complete data, write LENNOX, 619 S. 12th Ave., Marshalltown, Iowa.

HORIZONTAL MOUNTINGS



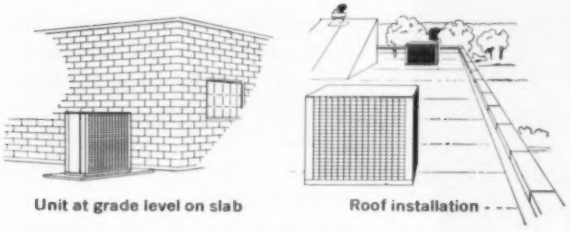
VERTICAL MOUNTINGS



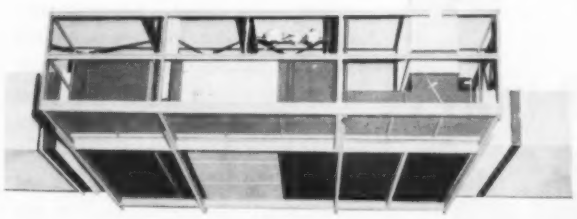


## Lennox Air-Cooled Condensing Unit for Commercial and Industrial Use

**Here's economy, ruggedness and application ease all in one unit. Exclusive circuiting method sub-cools the refrigerant so it reaches the evaporator much cooler than in average units; sub-cooling increases this unit capacity by 10%. Result: over 10 Btuh cooling per watt of total input (85° outdoor air). Straight-through air travel permits "stacking" of units, as in photo above.**



Unit at grade level on slab — Roof installation



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## EQUIPMENT DEVELOPMENTS

*Continued*

### Flow Meter for Water, Chemicals, or Processes

Propeller type, totalizing flow meter for metering water or chemicals, or for use in processes. Requires no pipes or mercury and totalizes directly. Cast iron body with molded plastic propeller will withstand and register overloads up to 150 percent. Available in eight different sizes, measuring from 20 to 2400 gpm, depending on line size. Accuracy within 2 percent of actual flow over the rated operation range, including temporary flow rates up to 150 percent of rated capacity. Send for bulletin No. 380.20-2. — *B-I-F Industries, P.O. Box* 276, *Providence* 1, *R. I.*

### Temperature Control System Features Modular Design

Accommodates various combinations of up to three different control modules in a 15 by 10 by 3.75 in. enclosed housing. Power supply, operating voltages, and a large clearly marked terminal strip are provided on the printed circuit masterboard. Bridge circuit requires no shielded wiring for remote sensing element hook-up. Humidity bridge is directly calibrated in percent relative humidity. Control amplifiers are available with actuator position indicators and manual over-ride switches. "Conditionaire" system operates with transistors. Send for bulletin and additional information. — *Fischbach and Moore, Inc.*, 545 *Madison Ave., New York, N.Y.*

### Electronic Heat Control Reacts to Outside Temperature

Unit consists of two parts: the control unit, installed in the boiler room, and the "Polarstat," a sensitive outdoor weather detector that reacts to temperature change, humidity, wind velocity and solar radiation. Two control discs are operated by an electric clock; one disc schedules the hours at which heat is required; the other disc schedules the quick morning "pick-up" heat load. Can be set to begin operation at from 47 to 60 F outdoor temperature. Available in 10 models. Send for bulletin. — *Fuel Watchman*, 77-29 138*th St., Flushing* 67, *N.Y.*

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Flexible, durable connections for pipe lines and other equipment handling fluids and gases under pressure and vacuum, to prevent excess stresses due to expansion and contraction; to counteract vibration; and to insulate against undesirable sound. Can also be designed to overcome misalignment.

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## EQUIPMENT DEVELOPMENTS

*Continued*

### Two-Stage Compressors Supply Up to 3000 Cfm of Air

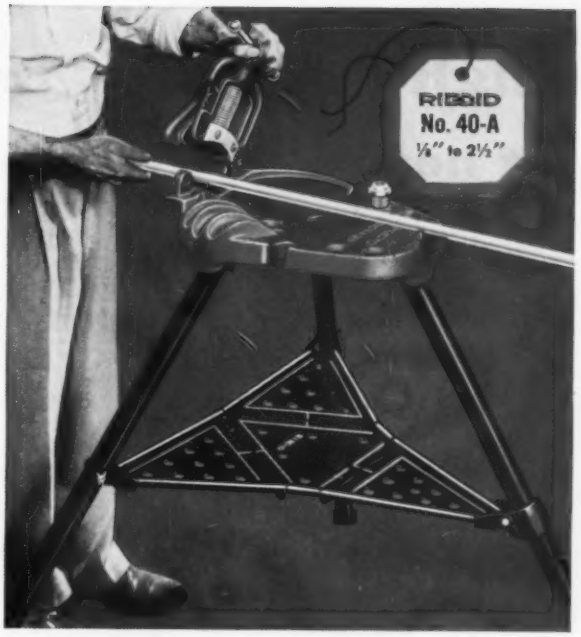
Units deliver up to 3000 cfm of oil-free air at 100 psig. Consists of two compressors driven in tandem by a standard 3600 rpm motor or turbine. Two intermeshing screw-type rotors provide axial-flow compression in each compressor stage. Units are air-cooled and include a diaphragm-operated air pressure relief valve and a discharge snubber. Available in seven sizes from 900 to 3000 cfm. Send for specification S-C100-161. — *Roots-Connersville Blower Div., Dresser Industries, Inc., Connersville, Ind.*

### Odor Control System For Air Conditioning Units

Designed for use with 5, 7½, and 10 ton packaged store units to permit vaporization of deodorizing fluid which cancels odors. Fluid container attached to suction side of air conditioning unit. For larger systems, gyrostatic evaporator may be used. No motor; air stream activates rotor on shaft containing discs submerged in deodorizing liquid. As rotor revolves, discs lift liquid into air stream where it is evaporated. Odor cancelling vapors are distributed throughout the system. — *Aireactor Corp.*, 271 *Madison Ave., New York* 16, *N.Y.*

### Remote Room Conditioners Provide up to 1200 Cfm

Remote individual room conditioners for use with central hydronic cooling and heating systems. Both concealed and cabinet styles available for vertical floor mounting. Each unit has two motors and four DWDI blowers. Capacities range from 200 to 1200 cfm. All models have accessible mounting brackets, piping and electrical lines, air vents, removable filters, and removable motor-fan assemblies. — *Bohn Aluminum & Brass Corp., Danville Div., Danville, Ill.*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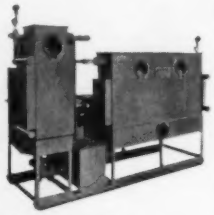

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## EQUIPMENT DEVELOPMENTS
*Continued*

### Extruded Aluminum Diffusers For Long Air Projection

Extruded aluminum, cylinder type diffusers for heating and cooling applications in any large interior where long projection of air or modulated diffusion is required. Unit consists of a rotary cylinder and split diffusing vanes. Cylinder can be adjusted for upward or downward or straight out projection. Split diffusing vanes can be adjusted for air direction blows — left or right or for modulated diffusion. Can be installed either in a horizontal or vertical position. Send for catalog RJ100. — *Air Devices Inc.*, 185 *Madison Ave., New York, N.Y.*

### Sun Reflecting Screen Controls Heat and Glare

A pre-framed louver shade screen between two panes of glass, hermetically sealed, provides control of solar heat gain and sky glare in window and wall construction. Requires no maintenance beyond the normal care given to glass windows. Information sent on request. — *Armour Glass Co.*, 8331 *Isis Ave., Los Angeles* 45, *Calif.*

### Electric Duct Heaters Have 107,500 Btu Per Hr Capacities

Units designed for use with firm's blowers or cooling units and are adaptable to any type of duct installation where blower cfm is sufficient. One cabinet size (20 × 14 × 14 in.) with five electric element sections provides a complete range of eight different output ratings from 30,700 to 107,500 Btu per hr. Cabinets are made of heavy gage steel, double wall construction. Elements available in 4500 and 7500 w capacities and are interchangeable. — *The Williamson Co.*, 3500 *Madison Rd., Cincinnati* 9, *Ohio.*

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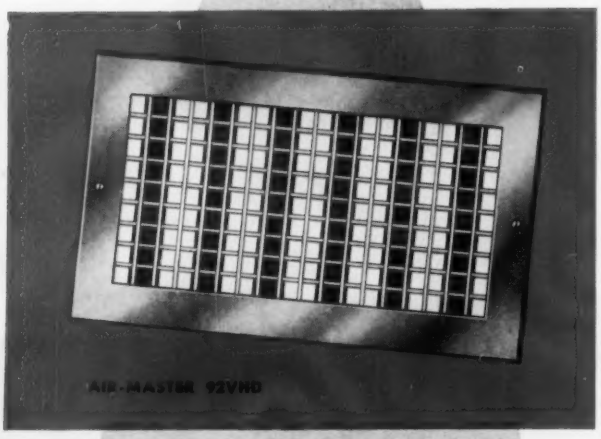


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A sturdy, yet lightweight unit that defies comparison for both beauty and performance.

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## EQUIPMENT DEVELOPMENTS

*Continued*

### Sub-Miniature Solenoid Valve Operates With All Common Media

Solenoid valve for use in hydraulic and pneumatic devices and control systems operates with all common media including many semi-corrosive fluids. Body and operating parts are stainless steel. Measures 1 in. in diameter, is 2¼ in. high, and weighs 5 oz. Orifices are 3/64 in. and fluid connections are 1/16 in. Fittings to adapt to standard ⅛ in. flared tube are provided. Operating differential pressures run from a vacuum of 5 microns to 150 psi. Three-way normally closed valves now available; other models available in future. — *Skinner Electric Valve Div., Skinner Precision Industries, Inc., New Britain, Conn.*

### Spray Nozzles Available in Small Critical Burner Sizes

All purpose nozzles available in sizes of 1.50, 1.65, 1.75, and 2.00 gph in addition to sizes through 1.35 gph. Information sent on request. — *Delavan Manufacturing Co., West Des Moines, Ia.*

### Controllers Available In Two Midget Sizes

Semi-automatic controller available in two miniature types: Model "EM-1" operates a single circuit and fits into a standard 2 × 4 in. electrical box; Model "EM-8" controls up to eight circuits, with selection of circuits made manually in any sequence. This model fits a 4 × 4 in. electrical box. Units switched on manually and shut off automatically at any predetermined interval up to 60 min. Information sent on request. — *Febco, Inc.*, 1993 *Blake Ave., Los Angeles* 39, *Calif.*

### Pressure-Vacuum Control for Air, Gas, or Liquid Applications

Skeleton pressure-vacuum control for air, gas, or liquid applications requiring close on-off differentials. Designed without an enclosure for direct incorporation into equipment. Adjustable ranges available within limits of 30 in. Hg vacuum and 500 psi, with off-on differentials from 1.5 ± ½ in. Hg to 10 ± 3 psi. Standard electrical ratings are 15 and 20 amp 115/230 v a-c. Switch action includes normally open, closed, and double throw; suitable for ambients up to 180 F. — *United Electric Controls Co., Dept. N., 85 School Street, Watertown 72, Mass.*

## EQUIPMENT DEVELOPMENTS
*Continued*

### 2½ Ton Condensing Unit Has 1855 Cfm Axial-Flow Fan

Unit has special coil circuiting that subcools refrigerant so that it is up to 20 F cooler than the condensing temperature when it reaches the evaporator. An axial-flow fan delivers 1855 cfm in a straight line pattern through the condenser which has 3.75 sq ft face area and four rows of ½ in. tubes. Includes a combination heating-cooling thermostat and auxiliary control box containing terminal strips and relays for controlling evaporator blower, compressor, and furnace. — *Lennox Industries Inc., Marshalltown, Ia.*

### Oil Burner Primary Control Available in Compact Size

Unit reacts only to the radiant rays from the oil flame, not to heat. Consists of two parts: a flame detector and a primary unit. Can be mounted on a 4 × 4 in. junction box. Weighs 2 lb, 6 oz. Send for folder R-1700. — *White-Rodgers Co., 9797 Reavis Rd., St. Louis 23, Mo.*

### Ball Bearing Has Flange-Type Iron Housing

Unit consists of a cast iron housing with a standard inner ring ball bearing and self-locking collar. Combination square and round bolt holes will accommodate carriage bolts or standard machine bolts. Bearing face on the collar is located flush with the face of the casting in such a way that water will not puddle when mounted for vertical shaft applications. Frame side is recessed to allow water or dirt to by-pass as well as to prevent build-up of air pressure against the bearing seal. Shaft sizes available from ½ to 1-7/16 in. OD, except for 13/16 in. OD. — *The Fafnir Bearing Co., 37 Booth St., New Britain, Conn.*

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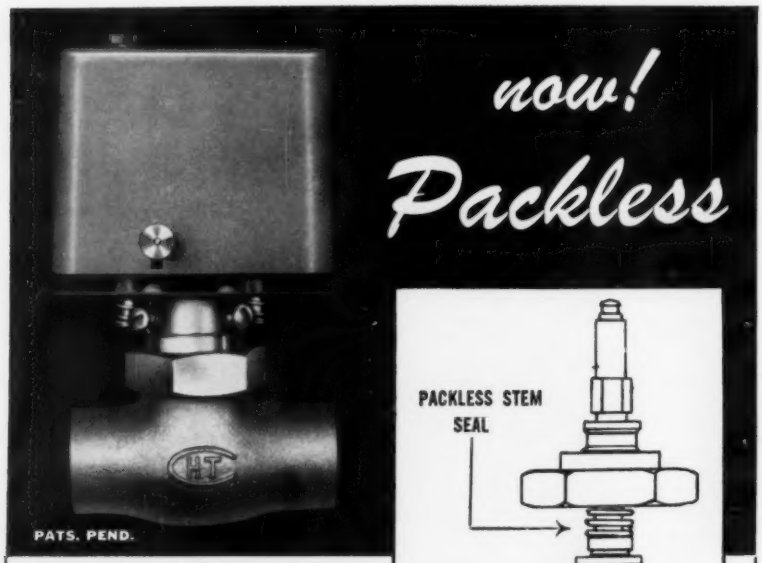
*For a list of manufacturers participating in AMCA's certified ratings program, write: Air Moving and Conditioning Association, Inc., 2159 Guardian Building, Detroit 26, Michigan.*




Electro tin-plated PHOSPHOR BRONZE BELLOWS eliminates packing and assures permanent sealing.

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## complete shut-off — no "seepage"

Engineers and heating men know—it's construction that tells the story!

Zonvalve's packless design utilizes an electro tin-plated Phosper Bronze Bellows to assure a permanent stem seal.

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Globe-type construction insures 100% shut-off. Positive temperature control because there is no heat waste through "seepage".

Zonvalve is easy to install—operates with equal efficiency when mounted in any position. Made in all standard pipe and tubing sizes, straight, angle and three-way—½" to 1¼".

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## EQUIPMENT DEVELOPMENTS
*Continued*

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Lightweight sound meter operates on an ordinary life 22.5 v battery with an operating life of 30 hr. Range of operation from 35 to 142 db sound level range and 40 to 8000 cps response. Completely transistorized meter comes in a heavy gage aluminum case. A direct reading scale minimizes chance of reading errors. Amplifier is stabilized against voltage and temperature changes. Send for technical bulletin. — *H. H. Scott, Inc., Instruments Div., Dept P,* 111 *Powdermill Rd., Maynard, Mass.*

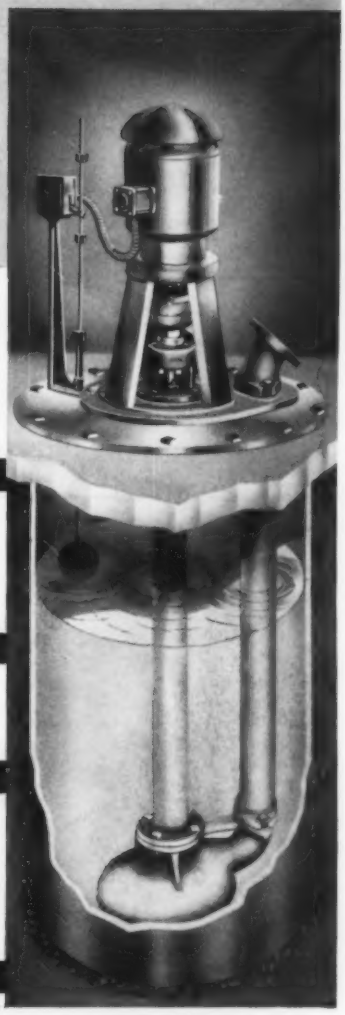
### Proportional Controller For Process Control

Unit for proportional off-on process control of temperature, pressure, liquid level, and other factors. Used with primary instruments such as indicators or indicating recorders having transmitting slidewires. Accuracy is ¼ of controller span as referred to accuracy of primary instrument. Unit has a fail-safe circuit. — *Thermo Electric Co., Inc., Saddle Brook, N.J.*

### Low-Pressure Spray Adhesive For Bonding Light Materials

Solvent-type adhesive particularly suited for bonding light-weight pieces of insulation. Sprayable at pressures of 5 psi. Provides adhesion of metal and plastic panels to such insulating materials as felt, asphalt-impregnated paper, glass fiber, polyethylene and polyurethene sponge and foam. Spray is a one-surface adhesive; drying time can be modified to conform with whatever speeds are desired. Resistant to moisture and temperature extremes. — *Anchor Adhesives Corp.,* 36-23 164*th St., Flushing* 54, *N.Y.*


SCREENLESS PUMPS
for
SEWAGE PUMPING
DRAINAGE PUMPING
with a REAL NON-CLOG IMPELLER



**This HEAVY DUTY Sewage and Sump Pump with the famous NON-CLOG Impeller, effectively handles large diameter solids, rags and stringy material which are washed into the sewage pit.**

**RUGGEDLY BUILT**

**This factory assembled unit has an ample reserve of strength to meet the most severe conditions and to furnish years of trouble-free operation.**

**SIMPLIFIED INSTALLATION**

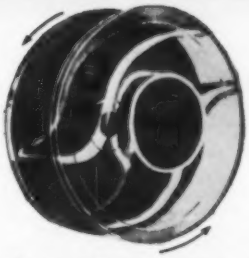
**Only one piping connection required. Only one electrical connection. An ECONOMICAL installation.**

**CAPACITIES**

**A large selection of units to meet every need. Capacities to 1500 GPM; heads to 86 feet; can be supplied with 1750 RPM, 1140 RPM or 870 RPM motors; four and five inch discharges.**

**NON-CLOG IMPELLER**

**The NON-CLOG Impeller built into this Screenless Sewage Pump supplies the ideal method of pumping sewage of other unscreened liquids containing solids. This design eliminates the necessity for expensive pneumatic ejectors and various other pumps requiring screening devices.**



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***Pumps of this design are still operating satisfactorily after 25 years in service.***

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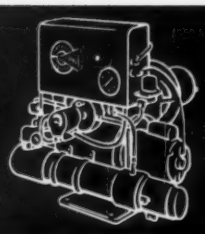
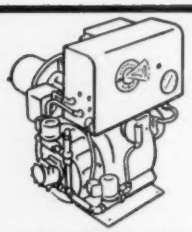
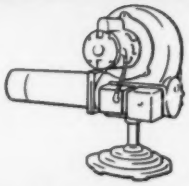
**weil PUMP COMPANY**
**1514 No. Fremont St.** **Chicago 22, Illinois**



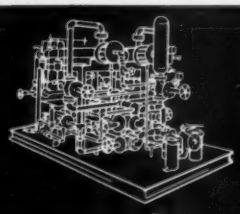
**C-45 PRESSURE ATOMIZING OIL BURNER** . . . forced or natural draft . . . for number 5 or lighter fuel oils . . . 7 models to 33 gph . . . UL approved. BULLETIN 100A.



**C-20 PRESSURE ATOMIZING OIL BURNER** . . . forced or natural draft . . . for number 2 fuel oil . . . 7 models to 33 gph . . . UL approved. BULLETIN 102.



**NAIROIL AUTOMATIC OIL BURNERS** . . . for firing small steam or hot water boilers, etc. . . . 4 sizes available ranging from ¾ to 20 gph of number 2 fuel oil. BULLETIN 113B.

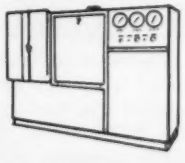


**PUMPING AND HEATING UNITS** . . . for problems involving heavy fuel oil for combustion. Single or duplex units from 2 to 100 gpm in standard or special models. BULLETIN 40.

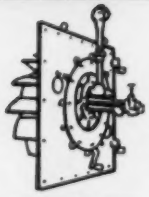
# We Make Them All!

From National Airoil . . . you can obtain a complete line of top-quality oil burners, gas burners and related combustion equipment shown here. Check your needs . . . we'll be happy to supply you with engineering data and assistance. No obligation, of course.

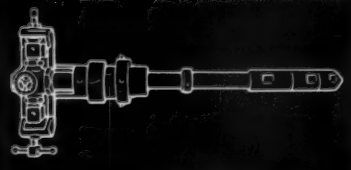
**DUAL STAGE OIL BURNERS** . . . for use when both mechanical and steam atomizing principles are incorporated in a single oil burner. 3 standard sizes. BULLETIN 25.



**AUTOMATIC PACKAGED FIRING UNITS** . . . Steam atomizing automatic firing units for oil and/or gas fuels. Standard unit capacities from 200 to 830 boiler horsepower (7,200 to 30,000 lbs of steam per hour). Larger units for special needs. BULLETIN 25.



**UNIVERSAL REGISTER UNITS** . . . a wide range of models including swing-type are available with capacities ranging from 60 to 500 gph. BULLETIN 51.



**STEAM ATOMIZING OIL BURNERS** . . . for use where steam or compressed air is available for firing many types of industrial process furnaces. 5 sizes have rated capacities from 10 gph to 725 gph. BULLETIN 73.

*Established 1912 . Incorporated 1917*

**NATIONAL AIROIL BURNER COMPANY, INC.**

**1284 E. Sedgley Avenue • Philadelphia 34, Pa., U.S.A.**

***Industrial Oil Burners, Gas Burners and Combustion Equipment***


## EQUIPMENT DEVELOPMENTS

*Continued*

### Spot Surface Thermostat Has Range from 0 to 540 F

Stainless steel unit measures temperature within 60 sec. Magnetic clip device available for use of thermostat on non-horizontal ferrous surfaces. Auxiliary pointers that record the minimum and maximum temperatures attained during the measuring period also available. Other ranges include: 50 to 1000 F; 50 to 500 F; 0 to 320 F; and 0 to 270 F. Diameter is 1¾ in. overall. Weighs 1/3 oz. — *Pacific Transducer Corp., 11836 W. Pico Boulevard, Los Angeles 64, Calif.*

### Repair Compound Bonds to Metal, Glass, and Wood

Repair compound consists of 80 percent bronze and 20 percent plastic. Hardens in approximately 2 hr without the use of heat or pressure. Bonds to iron, bronze, steel, aluminum, brass, wood, glass, and many other surfaces. Expands and contracts like metal. Tensile strength is 9000 psi; compression strength, 20,000 psi. Unaffected by oil, water, and most chemicals. Shrinkage during hardening is 0.0005 percent per in. Send for bulletin. — *Devcon Corp., Danvers, Mass.*

### Color Coding Enamels for Identifying Piping, Valves

Fast drying and permanent color coding enamels for identifying piping, valves, and other color coding operations available in 16 oz aerosol containers. Enamels in 18 popular colors, black and white lacquers and enamels, clear plastic, and flat black and zinc chromate primer. Bulletin E-611 listing all colors and other information sent on request. — *Reynolds Ink, Inc., 2075 East 65th St., Cleveland 3, Ohio.*

## EQUIPMENT DEVELOPMENTS
*Continued*

### Dust Collector Features Cleaning Booth

Unit consists of a cabinet cloth filter dust collector and a top-mounted cleaning booth in which small products can be freed of dust particles before packaging. Inside walls of cleaning booth finished in white enamel. A removable stainless steel screen forms the bottom of the booth. Dust collector contains 120 sq ft of cloth filter area. A 1 hp motor and blower moves up to 550 cfm of air through a 4 in. top inlet. Dust storage capacity is 780 sq ft. — *Torit Manufacturing Co., Dept. CB,* 1139 *Rankin St., St. Paul* 16, *Minn.*

### 225 Amp A-C Welder for On-the-job Applications

Transformer type arc welder will operate on a 220 v single phase power supply. Dial type current control for setting of unit over an amperage range from 40 to 225 amp. Electrodes from the smallest to 3/16 in. diameter can be used to weld material of any thickness. Includes welding cables, headshield, electrode holder, and ground clamp. — *The Lincoln Electric Co.,* 22801 *St. Clair Ave., Cleveland* 17, *Ohio.*

### Sight-Flow Indicators Have No Blind Threads

Sight-flow indicators for chemical processing applications have no blind threads. Flanged models feature rotable split-ring flanges to allow positioning in pipe line for best viewing angle. Pressure ratings to 500 psi; temperature ratings to 300 F. Cast iron, steel or stainless steel construction, screwed or flanged models available. Send for bulletin No. 820. — *Brooks Instrument Co., Inc., Hatfield, Pa.*


**KENNEDY'S**

**Union Bonnet and Cylindrical Body Increase Valve Life . . .**

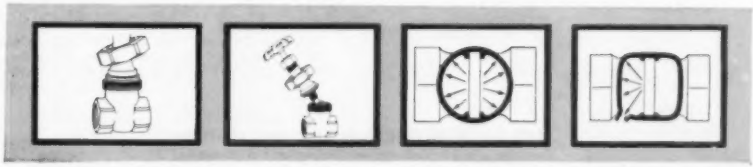
Heavy bronze union bonnet ring is entirely separate from the bonnet to eliminate any possibility of springing the bonnet face when assembling or disassembling the valve.

Cylindrical body withstands sudden pressure. This construction resists rupture and minimizes deflection when under severe pressure. Pressure in ordinary valve bodies tries to push the body wall out. Rupturing stresses concentrate where wall has the shortest radius. This deflection causes early valve failure in ordinary valves.

● *Write today for complete details.*

**Fig. 525**

125 lb. S.W.P. Bronze Gate Valve
Union Bonnet ● Rising Stem
Inside Screw ● Wedge Disc



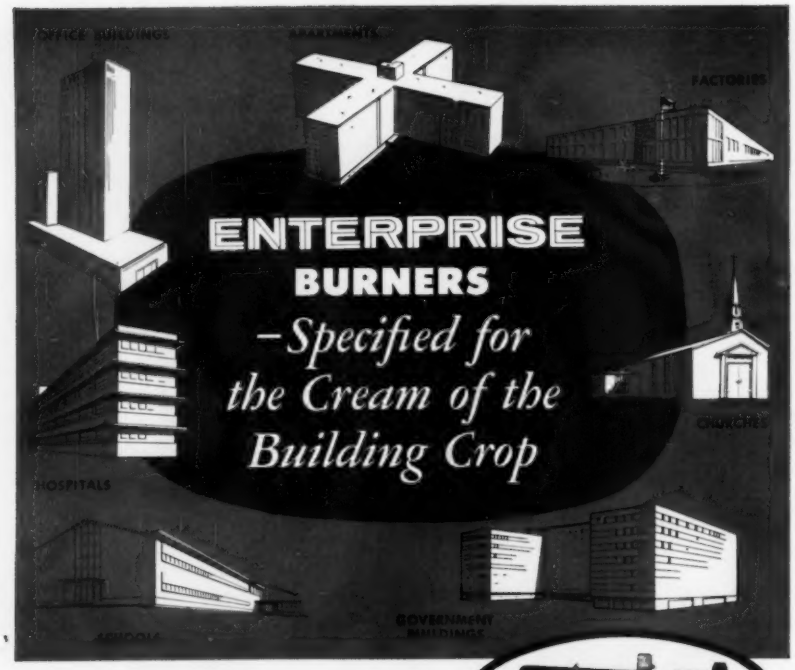
Kennedy's Union Bonnet permits repeated dismantling for cleaning or inspection and reassembly without danger of distortion of the valve. The bronze-to-bronze construction makes a tight union for tight, leakproof operation.

Kennedy's Fig. 525 can be easily disassembled into component parts for installation in otherwise inaccessable places in existing lines or for new installations.

Kennedy's cylindrical body construction when under severe pressure resists rupture and minimizes deflection thus preventing leakage at the seat.

Pressure in ordinary non-cylindrical valve bodies tries to push the body wall out to form a circle or cylinder. Rupturing stresses concentrate where wall has the shortest radius. Resultant deflection causes leakage over disc and early failure.

**KENNEDY VALVE MFG. CO.**
ELMIRA; NEW YORK
VALVES • PIPE FITTINGS • FIRE HYDRANTS
● OFFICES AND WAREHOUSES IN NEW YORK, CHICAGO, SEATTLE, SAN FRANCISCO, ATLANTA ● SALES REPRESENTATIVES IN PRINCIPAL CITIES ●



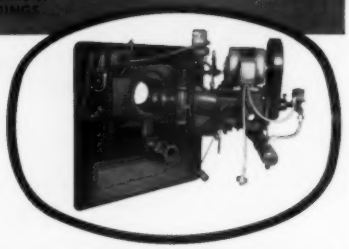

## A History of 30 Years' Leadership Backs Your Choice of Enterprise

**First in Burner Design**

Scores of original burner developments were Enterprise "firsts." V-Belt Drive, used exclusively on all Enterprise Burners since 1938, introduced new flexibility, efficiency and economy to horizontal rotary burner operation. The remarkable Enterprise "Measured-Rate" Metering Pump brought an end to problems of oil flow due to varying oil temperatures and viscosity. These and other contributions to better burner service reflect the efforts of a continuing program of product development at Enterprise.

**The Quality-Built Burner Line**

Only the finest of materials are used in manufacturing Enterprise Burners. Every phase of production is precisely controlled by expert craftsmen to maintain highest quality standards. No wonder Enterprise Burners are built better, cost so little to operate and maintain, insure long, efficient, trouble-free service.



**Only Fully Qualified Distributors and Dealers Serve You**

An unusually high percentage of Enterprise Distributors and Dealers have been selling and installing Enterprise Burners for from 10 to 30 years. Enterprise works closely with these distributors, offering complete engineering service on such things as combustion chamber design, correct piping arrangements and electrical diagrams—to assure you of the most efficient operation of your Enterprise Burner.

These are the plus factors you enjoy when you specify Enterprise—first choice in burners where quality comes first.

Available in sizes from 4 to 200 gallons per hour. Listed by Underwriters' Laboratories, Inc., U.S.A., Underwriters' Laboratories of Canada, and approved by the Canadian Standards Association.

**SEND FOR *NEW FREE*, fully illustrated specification sheets on Enterprise Industrial, Automatic, and Combination Gas-Oil Burners.**

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**BURNER DIVISION**
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DISTRIBUTORS IN PRINCIPAL CITIES THROUGHOUT THE U.S. AND CANADA

## EQUIPMENT DEVELOPMENTS
*Continued*

### Pipe Reducers Eliminate Multiple Connections

Pipe reducing adapters, bushings, couplings, and nipples designed to eliminate multiple connections by providing one fitting reductions between all sizes in the range of 1/16 through 1 in. pipe. Fittings for use with pipe Schedules 40 through 80. Available in aluminum, brass, steel, Type 316 stainless steel, monel, polyethylene, and zytel (nylon). Information on other machineable metals or plastics available sent on request. — *Cajon Machine Co., 902 E. 140th St., Cleveland 10, Ohio.*

### Disposable Filters For Forced Air Systems

Filters contain a gridwork of activated charcoal coated fiber strips in a paperboard frame for odor removal in forced air ventilating systems. Air resistance 0.04 in. WG at 300 fpm. Installed and disposed of without mechanical change. Can be constructed to meet any specification, and comes in all standard sizes with or without dust media. Send for Bulletin E-190. — *Barnebey-Cheney Co., Cassady at Eighth, Columbus 19, Ohio.*

### Relief Valve Has Metal And Resilient Seal Seating

Relief valve has combination metal and resilient seal seating, and is internally adjustable through a wide range. Steel units have "Teflon" seals and are available in 10 connection combinations of 1/4, 3/8, and 1/2 in. dryseal pipe sizes. Rated at 10 gpm with relieving pressure settings up to 2000 psi. Information sent on request. — *Kepner Products Co., 7303 W. 59th St., Summit, Ill.*

## you'll want to know

*Continued from page 36*

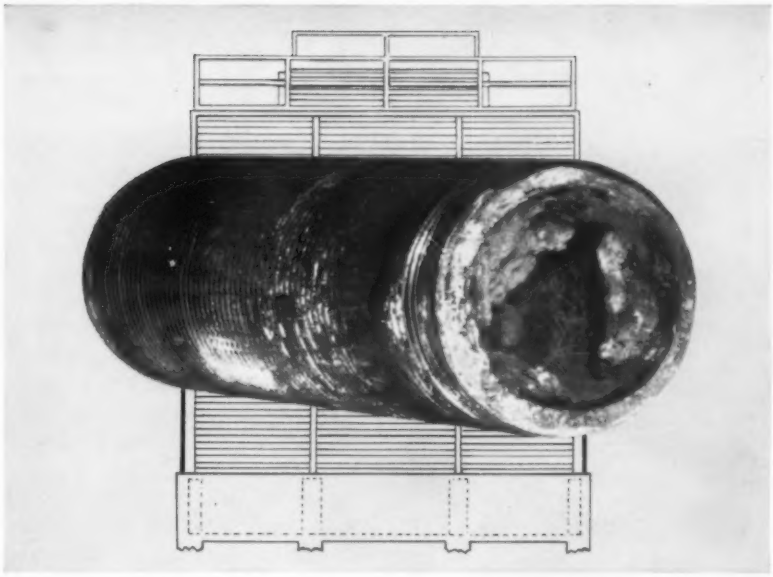
Board said caution should be exercised to avoid any inference that might open the door to anti-trust investigations.

A report by former C.E.C. president, Charles C. Pate, of Tulsa, Okla., indicated that competitive bidding has become acute in certain areas. Mr. Pate reported briefly to the meeting on the results of a recent questionnaire survey conducted by a joint committee of the American Institute of Consulting Engineers, the American Society of Civil Engineers, and the C.E.C. While a majority of those replying to the poll felt that consulting engineers should not respond to an advertisement to bid, some members replied that they saw nothing wrong in the provision of cost estimates. As evidenced by such replies, Mr. Pate cited the need for a standard of guidance to define what is negotiation and what is bidding.

It is the committee's intention that the results of the bid questionnaire survey shall provide the basis for a formal C.E.C. policy statement on this issue. In the meantime, the Council intends to pursue its current practice of handling competitive bid situations as they arise. In the case of government agencies, an almost 100 percent success record has been compiled. In cases involving municipalities, success has been slow and indefinite.

One of the major problems confronting the engineer in private practice continues to be encroachment by government agencies, according to the C.E.C. A "Private Enterprise" committee has been established to combat such competition. Tactics of the committee have included special "free enterprise" memoranda delivered personally to congressmen by joint delegations of architects, contrac-

*Continued on page 208*

**COOLING WATER CORROSION MUST BE STOPPED!**

Unchecked scale deposit and corrosion in your air conditioning system can cut its life by years . . . increase maintenance and replacement problems several-fold.

Bird-Archer Series 5900 chromate formulations stop severe scaling and corrosion easily, effectively and economically, adjust pH to safe, neutral ranges. In small systems, treatments are added to the circulating water directly from the shipping container through a specially designed Micro-Feeder, eliminating the necessity for manual, daily chemical feeding. For larger units special chemical feed equipment is available.

Write for Bulletin 117 and the name of the Bird-Archer Service Engineer nearest you.

BA-100

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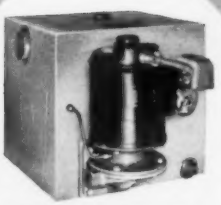
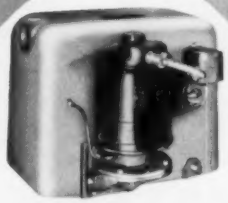


**4100 Series STEEL TANK**
Efficient operation . . . neat, compact design. All principal parts (motor, pump, float switch, drain plug) in front — for easy service.



**4200 Series CAST IRON TANK**
Exactly the same design and performance as the 4100 series, except for cast iron tank where necessary or desirable.

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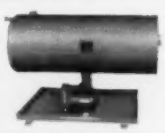
CAPACITIES: 2000 TO 15,000 SQ. FT. E.D.R.

Sterlco pumps are specially engineered . . . they are not adaptions of industrial or water supply pumps. Both series can deliver full rated output continuously, for long periods. Efficient impeller design prevents serious overloading of motors under any conditions.

*SPECIAL APPLICATIONS — For boiler return systems, greater capacities, or higher pressures, the 3500 series is available. It can be built to handle any job.*



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## you'll want to know

*Continued from page 207*

tors, and engineers. Response has been favorable.

In much the same vein, the C.E.C. Board expressed strong concern over reports that tax-free research institutes are, in many areas, offering to provide complete engineering studies on projects normally handled by consultants. In discussions regarding this problem, attention was called to statements by one such organization that "As a non-profit institute we would, without a doubt, plow a lot more money into the project than we receive as a fee."

Taking exception to such practices, C.E.C. Directors expressed the opinion that "research institutes were primarily established to undertake theoretical research and development which may include engineering research. In such instances, consulting engineers should undertake the actual engineering work, including preliminary studies, planning, and the design phases of the project."

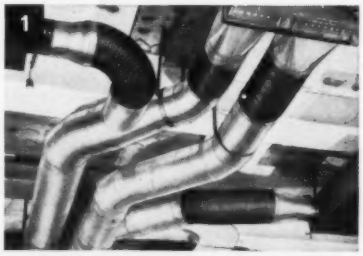
### Free Engineering

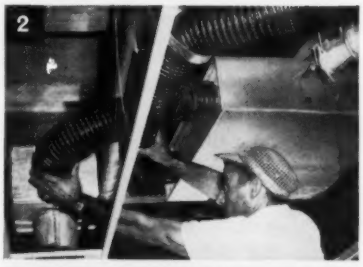
A procedure for the formal disposition of future "free engineering" complaints was outlined by former Council president, Ralph M. Westcott of Los Angeles. Members were invited by Mr. Westcott to keep the Council advised of manufacturers, contractors, or others who directly, or indirectly, offer to provide engineering services at reduced or no cost.

C.E.C. continued its remarkable growth record, an average of at least one new member association per meeting. The Council received and accepted an application for membership submitted by the Practicing Engineers and Land Surveyors of Wyoming. Seated as the Wyoming delegate to the C.E.C. Board was John S. Bereman

*Continued on page 209*


**which system is HIGH VELOCITY? MEDIUM VELOCITY? LOW VELOCITY?**



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## you'll want to know

*Continued from page* 208

of Cody. Acceptance of the Wyoming group boosted to 33 the number of Associations formally affiliated with the Council. Well over 1100 consulting firms in all fields of practice comprise C.E.C.'s individual membership.

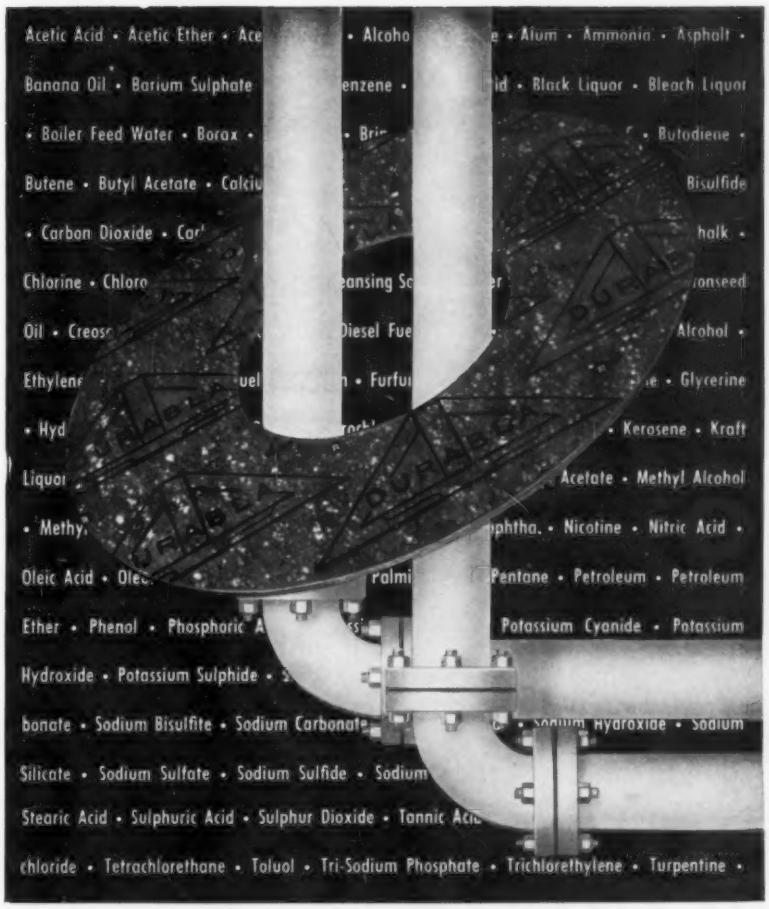
The growing importance of engineers in the building industry was discussed by John E. Haines, vice president of Minneapolis-Honeywell Regulator Co. Speaking as a member of the Board of Directors of The Producers' Council, Mr. Haines said, "The Producers' Council recognizes the constantly growing importance of the engineer in the building industry. For example, the mechanical and electrical engineering facilities content of a modern building alone, usually amounts to from 40 to 60 percent of the total cost of the building."

The problem of restricting telephone listings solely to qualified consulting engineers appears to be nearer a solution than ever before, it was reported. An extensive report by the Council's Telephone Listings Committee proposed a trade-mark listing to be purchased, as a "block," by the local member associations. Format and copy will be standardized by the Council to insure similarity in all U.S. phone directories.

The new officers of the Council installed at the Chicago meeting are: president, Harold P. King, Sherman Oaks, Calif.; first vice president, Cedric R. Acheson, Syracuse, N.Y.; second vice president, Sanford K. Fosholt, Muscatine, Ia., and treasurer, George W. Poulsen, Jr., Salt Lake City, Utah. Re-elected secretary is George J. Toman, Mandan, N.D.

The next meeting of the Consulting Engineers Council Board will be held November 2-4, in Miami Beach.

*More items on page* 210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Bisulfide
• Carbon Dioxide • Car
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Acetate • Methyl Alcohol
• Methyl
phtha. • Nicotine • Nitric Acid •
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ralmi
Pentane • Petroleum • Petroleum
Ether • Phenol • Phosphoric A
Potassium Cyanide • Potassium
Hydroxide • Potassium Sulphide •
bonate • Sodium Bisulfite • Sodium Carbonate
Sodium Hydroxide • Sodium
Silicate • Sodium Sulfate • Sodium Sulfide • Sodium
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**The versatility of this material results from the use of a greater percentage of selected Canadian asbestos fibre, of the spinning group, than is found in any other gasket material. The asbestos is skillfully compounded with a special binder. Every square inch of the sheet has uniform density, thickness and asbestos distribution.**

**DURABLA Sheet Packing is available in eight different gauges. Gaskets are supplied in all sizes and shapes, accurately machine cut.**

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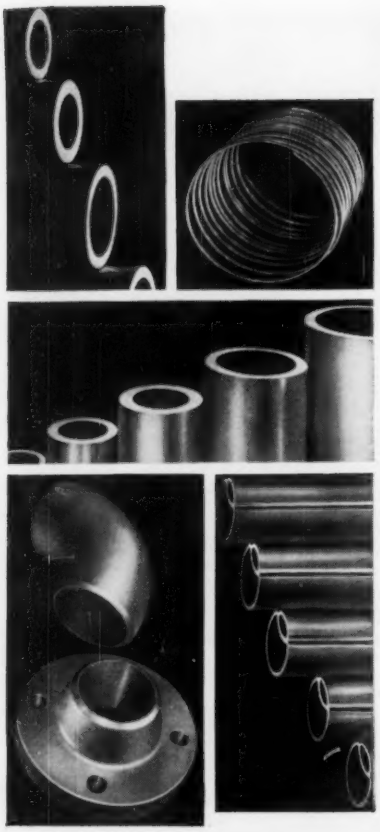

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## you'll want to know

*Continued from page 209*

### New ARI Committee Will Study Local Laws and Regulations

LOCAL air conditioning and refrigeration laws and regulations will be put under close scrutiny by a new committee formed by the Air-Conditioning and Refrigeration Institute. Temporarily named the Committee on State and Municipal Laws and Regulations, the new group recently held a meeting in Washington, elected a chairman, and approved a tentative scope of activities.

The scope of the Committee, as tentatively adopted at the organizational meeting, is as follows:

"(A) Keep advised of all impending codes involving public health and safety and affecting the design, manpower, sale, installation, operation, and service of air conditioning and refrigeration systems. Areas of interest to be considered, but not limited to the following:

1) Refrigeration Codes and Regulations
2) Air Conditioning Codes and Regulations
3) Heating Codes and Regulations
4) Electrical Codes and Regulations
5) Ventilation Codes and Regulations
6) Noise Regulations
7) Operating Engineers' Requirements
8) Contractor and Journeyman Licensing and Bonds
9) Unfired Pressure Vessel Codes - Boiler and Furnace Codes
10) Underwriters' Laboratories, Inc. Requirements

*Continued on page 211*

Safety and Relief Valves with a STRAIGHT "A" AVERAGE

APPROVAL (ASME)

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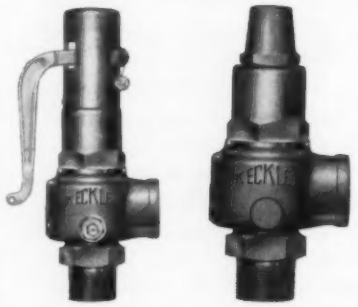
AVAILABILITY

**Keckley Pop Safety and Relief Valves meet A.S.M.E. requirements and are suitable for steam, liquid, air and gas service. Sizes from ½" to 2½". Bronze bodies, for pressures to 300 lbs. at temperatures to 425° F.**

**By combining 45 years of experience in the valve business, the latest machinery and methods, and a modern plant, Keckley assures you of quality products, with a good name, *always ready for shipment*. And you will be pleased with the cooperative engineering service you receive from Keckley in meeting your requirements.**



**No. 40 Safety Valve** **No. 42 Relief Valve**

***Write for Bulletin No. 660***

O. C. KECKLEY COMPANY
General Offices and Factory
3400 Cleveland Street
Skokie, Illinois

KECKLEY

Pressure Regulators • Temperature Regulators • Float Valves • Strainers • Solenoid Valves • Reducing Valves • Pop Safety Valves • Relief Valves

## you'll want to know

*Continued from page* 210

11) National Board of Boiler Inspectors' Requirements
12) Promulgation of Standards and Certification Documents

"(B) Act as a liaison committee with other committees and product sections of ARI.

"(C) Act as a liaison committee with other trade associations interested in the public safety and health aspects of air conditioning and refrigeration.

"(D) Continue to promote the adoption of the ASA B9. 1-1958 Code and any subsequent revisions of this Code where it is apparent that municipal or state authorities are actively engaged in the formulation of codes or regulations affecting air conditioning or refrigeration.

"(E) Review other related codes or regulations that affect the public health and safety involving the use of air conditioning and refrigeration. Determine what modifications in such codes and regulations, if any, would be to the best interests of the public and the industry as a whole; for example, electrical, plumbing, and heating codes.

"(F) Review and call attention to those things which, under the guise of safety, may be in fact activity directed in restraint of free trade."

## Correction Notice

In the June issue of Heating, Piping & Air Conditioning there appeared, on page 4, an advertisement for Air Conditioning, Inc., in which an error was made. In the third paragraph, the overprint in color, "500" should not have appeared. We are informed that over 1000 of these units are now in operation in the United States.

*Send for FREE Data Book*

LET BURT MAKE AIR WORK FOR YOU

**391 Standard Models To Choose From PLUS Complete Facilities To Design And Manufacture Special Ventilators**

| BURT VENTILATOR | TYPE | CAPACITY (CFM) | SIZES | MODELS | DISCHARGE |
|---|---|---|---|---|---|
| FREE-FLOW GRAVITY | Gravity | 113 to 35,560 | 16 | 16 | Upward |
| LO-HYT GRAVITY | Gravity | AS REQUIRED | 18 | 18 | Downward |
| MONITOR | Gravity | MADE TO ORDER | | 1 | Upward |
| MONOVENT (Ridge) | Gravity | 48 to 5,184 | 15 | 15 | Upward |
| REVOLVING | Gravity | 123 to 10,931 | 17 | 17 | Sideward |
| STANDARD GRAVITY | Gravity | 35 to 24,890 | 19 | 19 | Upward |
| THERMAVENT | Gravity | MADE TO ORDER | | 2 | Upward |
| CENTRIFLOW | Power | 65 to 36,430 | 56 | 184 | Downward |
| FREE EXHAUST FAN | Power | 5,000 to 75,550 | 7 | 17 | Upward |
| FREE FLOW FAN | Power | 1,040 to 99,050 | 15 | 35 | Upward |
| LOW TYPE | Power | 337 to 47,400 | 15 | 60 | Downward |
| STANDARD FAN | Power | 685 to 15,000 | 10 | 10 | Upward |

There is a type of Burt Ventilator to meet any ventilating problem that Roof Ventilators can solve. Burt's specialized engineering, equipment and craftsmanship—from 60 years of designing and building ventilators—is your assurance of complete satisfaction. Cost economies are assured from almost 400 *standard* models that are quickly available. Write for Burt's Complete Line Data Book—it's free!

VENTILATORS • LOUVERS • SHEET METAL SPECIALTIES

The Burt Manufacturing Company

41 East South St. Akron 11, Ohio

MEMBER AIR MOVING & CONDITIONING ASSOCIATION, INC.

# CLAIR COAT

**A Superior**

**LAGGING ADHESIVE**

Created By St. Clair Rubber Co. for the toughest pipe and duct Lagging applications.

**NOTE THESE 10 HIGH SCORING POINTS**

FAST SETTING - Sets almost immediately for faster application.

LOW FREEZING POINT - Usable after being frozen solid.

NONFLAMMABLE — With fire retardant dried film.

STRONGEST PERMANENT BOND - Proved by comparative tests.

ONE COAT NEEDED - For sleek, semi-gloss finish.

STEAMPROOF - WATERPROOF
By contractors's tests.

NON TOXIC - VERMIN PROOF
Will not settle in container.

FINE APPEARANCE - EASILY WASHABLE - Provides long lasting protection.

**Also New**
**St. Clair LAP SEALING ADHESIVE #45007**

Featuring

FASTEST APPLICATION - No waiting for open time.

ONLY ONE COAT NEEDED

IMMEDIATE TACK - FAST GRAB with STRONG BOND.

FINE BRUSHING CONSISTENCY

WHITE COLOR - No. 45007

TAN COLOR - No. 4570

PERM RATING of .05

NO LAP FAILURES
Laboratory controlled quality.

REPLACES STAPLING - BANDING

HEAT RESISTANT to 300° F.

HIGH STORAGE STABILITY
Several container sizes available.

Write for literature - prices - samples, of either or both adhesives

**ST. CLAIR RUBBER CO.**
Empire Bldg.
107 Clifford St. Detroit 26, Mich.


# RECENT TRADE LITERATURE . . .

## Heat Exchangers

Two page bulletin No. 451 describes heat exchanger series featuring removable bundles with floating clamp-ring design. Units are fabricated from standard pre-engineered components combined into custom-built assemblies with 19 shell sizes from 6 through 42 in. and in any practical tube length. Includes specifications and an exploded view line drawing with components listed. — *American-Standard Industrial Div., Detroit 32, Mich.*

## Fluid Heat Transfer

Four page bulletin BRP100-1 describes automatic electric fluid heat transfer systems available in 10 standard models. Systems include: electric immersion heaters; high temperature pumps; by-pass relief valve; strainer; expansion tank; temperature controls; contactors; disconnect switches; and safety devices. All joints are welded. Flow diagram shows position of components. Gives application data and specifications. Illustrated with photos, line drawings, and tables. — *Edwin L. Wiegand Co., 7500 Thomas Blvd., Pittsburgh 8, Pa.*

## Gas Fired Boilers

Bulletin HY-F237 describes gas hot water heating system with electronic step-control. Control step-fires the system's separate combustion chambers in response to outdoor temperature, modulating the supply water temperature in accordance to load requirements. Capacity range is 360,000 to 3,600,000 Btu per hr input. Bulletin includes schematic drawings and photos of installations. — *Hydrotherm, Inc., Dept. AC-7, Northvale, N.J.*


# SOPLASCO
PLASTIC
Moisture
# ELIMINATOR BLADES
FOR INDUSTRIAL AIR CONDITIONING
ARE

**MORE ECONOMICAL**

SOPLASCO Plastic Moisture Eliminator Blades are the finest at he greatest economy. The outsanding physical and chemical properties of SOPLASCO blades make them more efficient with a minimum of maintenance.

**Southern Plastics Co.**
408 Pendleton St.
Columbia, S. C.

For further information write, wire, or phone SOPLASCO AIR PRODUCTS DEPT.

## RECENT TRADE LITERATURE
*Continued*

### Water Chilling Systems

Two page bulletin describes water chilling systems with gas engine drives. Capacities are from 90 to 600 tons. Specifications given for compressor, condenser, chiller, control, and engine. Lists approximate dimensions in table form, keyed to line drawings. — *York Corp., Grantley Rd., York, Pa.*

### Centrifugal Pumps

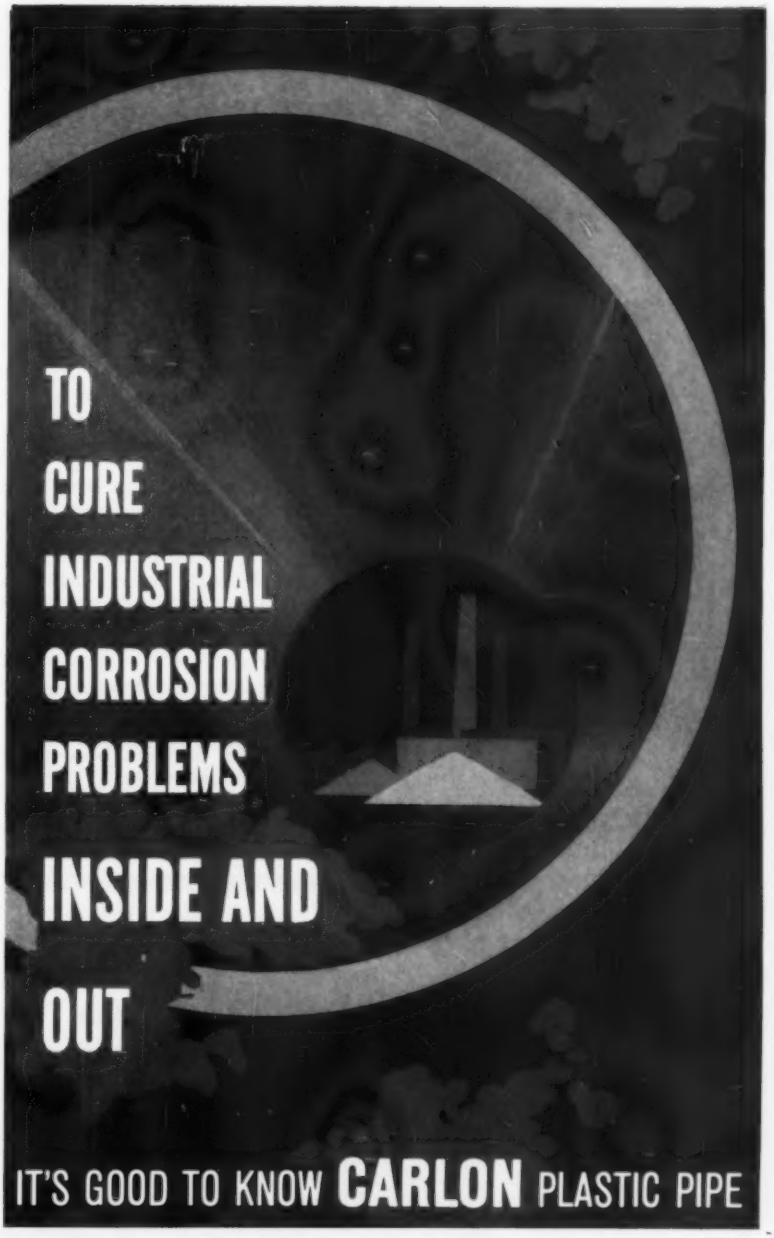
Four page bulletin 117 PKG describes close-coupled end-suction centrifugal pumps. Units allow complete disassembly without disturbing the suction or discharge piping. Vertical centerline discharge makes units self-venting to eliminate vapor locks and provide operation with a low noise level. Bulletin includes cross-sectional views, construction specifications, performance charts, and dimension data. — *Aurora Pump Div., The New York Air Brake Co., Loucks at Dearborn, Aurora, Ill.*

### Gas Fired Unit Heaters

Literature describes gas fired suspended unit heaters. Includes application data. Printed in three colors. — *Mueller Climatrol, Div. of Worthington Corp.,* 2005 *W. Oklahoma Ave., Milwaukee* 1, *Wis.*

### Variable Speed Drives

One hundred twelve page catalog describes "lube-free" integral and fractional hp variable speed drives. Cutaway drawings and photos illustrate working parts. Includes modifications such as single, double, and triple reductions, as well as various horizontal and single and double worm assemblies. Covers 2:1 to 6:1 variations and maximum variations. Information given on accessories and dimensions. — *Sterling Electric Motors, Inc.,* 5401 *Telegraph Rd., Los Angeles* 22, *Calif.*


Carlon's new Plastic Pipe Fact-pak can save your company money. Includes chemical resistance tables, operating temperatures and pressures. *Write for yours.*

KNOW THE FIRST NAME IN PLASTIC PIPE
CARLON

**CARLON PRODUCTS CORPORATION**
**Box 133 — Aurora, Ohio — Dept. HP-5**

Please send me the new Plastic Pipe Fact-pak.

NAME_____
TITLE_____
COMPANY_____
ADDRESS_____
CITY_____ STATE_____

At CUMMINS ENGINE COMPANY'S
New Test Building ··· water pump systems
run safely and silently

Figure 636 Globe-Type Silent Check Valve installed at Cummins' Test Building. Available for 3" to 24" lines.

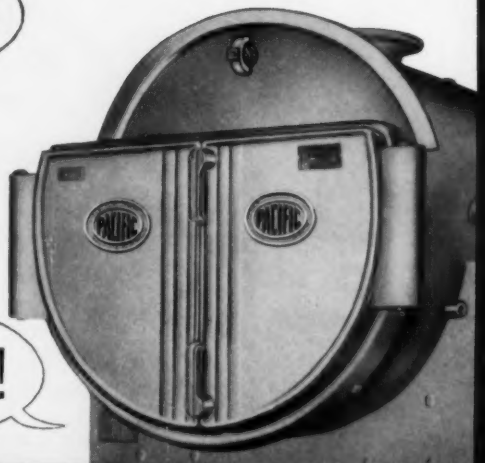
Eighteen Williams-Hager Silent Check Valves are installed on boiler feedwater, condensate and vacuum pump lines, as well as dynamometer and engine cooling water pump systems, in the new Engine Test Building at Columbus, Indiana. These check valves operate the instant flow reversal starts, eliminating pressure surges and resulting water hammer before they are created. Result: assured silence and safety of liquid systems.

WILLIAMS · HAGER Silent Check Valves

*Write for Bulletins:* No. 654 on Valves; No. 851 on Cause, Effect and Control of Water Hammer; No. 659 on Pressure Loss Tests.

**The WILLIAMS GAUGE CO., Inc.**
155 Stanwix Street
2 Gateway Center • Pittsburgh 22, Pa.
Our 75th Year • 1886-1961

What's the biggest name in steel heating boilers?



PACIFIC!

Pacific makes the most complete line of low pressure steel heating boilers. Has specialized in designing and building large steel boilers for close to 50 years. Thousands of installations the world over. You benefit because Pacific men are boiler experts. There's a Pacific representative in your area. Call him for your next boiler.

PACIFIC STEEL BOILER DIVISION
Division of Crane Co., Johnstown, Pennsylvania
AT THE HEART OF HOME AND INDUSTRY
CRANE
VALVES AND PIPING · ELECTRONIC CONTROLS
PLUMBING · HEATING · AIR CONDITIONING

## RECENT TRADE LITERATURE
*Continued*

### PVC Plastic Pipe and Fittings

Sixteen page brochure No. 620 includes application information, sizes, and specifications for Schedules 40, 80, 120, and A pipe. Gives drawings and sizes of threaded and solvent weld fittings. Corrosion resistance table of 390 chemicals gives head losses, working pressures, expansion and contraction tables, and recommended support spacing. — *Carlon Products Corp., P.O. Box 133, Aurora, Ohio.*

### Electric Motors

Sixteen page bulletin No. 010 describes single phase, three phase, and direct current motors. Also describes speed drives and allied equipment. Includes two selection charts, ratings, and dimensions. Illustrated with photos, tables, line drawings, and graphs. — *Century Electric Co., 18th & Pine Sts., St. Louis 3, Mo.*

### Magnetic Motor Starters

Four page bulletin GEA-7321 describes combination safety magnetic motor starters that offer protection against unauthorized entry and personnel injuries. Photos illustrate safety devices and show how to perform inspection or maintenance with or without power interruption. — *General Electric Co., Schenectady 5, N.Y.*

### Grille Selector

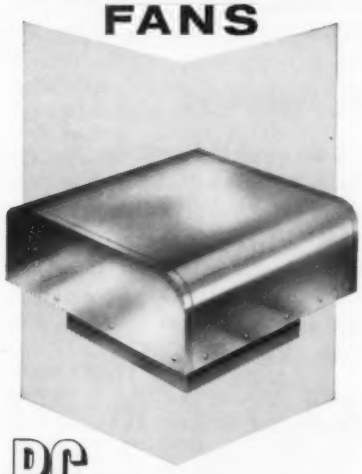
Slide rule serves as an air flow calculator and an outlet selector. Determines the air flow rate for any diffuser or grille from velocity measurements in the field. Can be used for all anemometers and their K factors. Determines outlet and size based on available space and noise criteria. Provides complete throw, drop, and performance of outlets. A 24 page instruction booklet explains use. Price is $2.50. — *Titus Manufacturing Corp., Waterloo, Ia.*

# LOW PROFILE

# DAVIDSON

ROOF EXHAUST

**FANS**



**PC** *Pleasing Contour Model*

Designed to "hug the roof", the low-contour PC Model is as much as 40% lower than conventional units.

Capacities up to 50,000 CFM with low velocity.

- Quiet, vibration-isolated operation
- Famous Davidson rugged construction
- NEMA Standard Motors
- Ratings conform to Standard Test Code
- Unconditional performance guarantee

*For complete facts about PC Fans and Hyduty SS Fans, write:*

**DAVIDSON FAN CO.**

Dept. D, 213 California St.
Newton 58, Mass.

***The original manufacturer of roof fans — Founded 1915***

Member AMCA


## RECENT TRADE LITERATURE

*Continued*

### Pressure Pipe Welding

Twenty page bulletin 2112.2 explains welding of pressure pipe lines and piping systems. Contains information on techniques and costs related to cross country transmission and pressure piping systems. Also reviews API pipe specifications, analysis, and physical properties, and contains charts on lb of electrode consumed per joint for various diameter pipe using either hand or fully automatic submerged arc welding. — *The Lincoln Electric Co., Cleveland 17, Ohio.*

### Indirect-Fired Heaters

Eight page bulletin 400 describes heaters used in the petroleum, petrochemical, chemical, power, and related industries to heat gases, steam, and other vapors, heat transfer oil, and other liquids. Fired indirectly by gas, oil, or gas-oil, units maintain low metal wall temperatures and do not require refractories. Temperatures range to 1200 F, capacities up to 5,000,000 Btu per hr, and pressures up to 300 psig. Also describes auxiliary equipment including burners, flame safety equipment, and controls. Illustrated with photos, line drawings, and tables. — *Brown Fintube Co., 300 Huron St. Elyria, Ohio.*

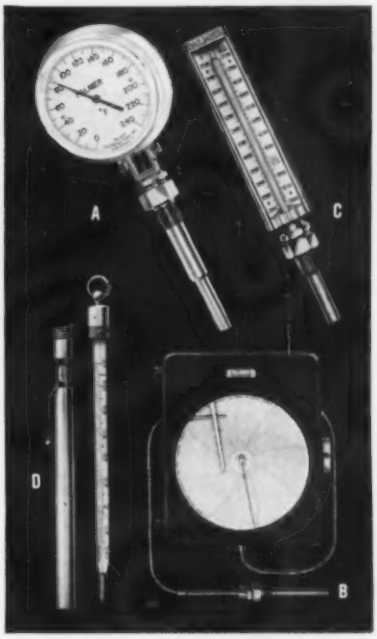
### Manometer

Bulletin describes unit with an integrally cast solid wall in the gage to protect against explosive forces resulting from Bourdon tube rupture. The wall separates the Bourdon tube assembly from the ring, glass, and dial. The glass itself is a safety type, adding further protection. Full access to the Bourdon tube assembly and the movement allows easy inspection, repair, or recalibration without removing the ring assembly or dial. — *J. E. Lonergan Co., 211 Race St., Philadelphia 6, Pa.*


A GREAT NAME IN THERMOMETERS

# PALMER

Mercury Actuated
Temperature Indicating Instruments




**A—4½" DIAL THERMOMETERS:** Made in 3 types to suit any requirements. Rigid stem, wall or flush mounted, 11 inches of scale reading. Interchangeable with standard industrial separable sockets. Stem can be placed at any angle and case can be rotated to any readable position.

**B—RECORDING THERMOMETERS:** Twelve inch die-cast aluminum case with black finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges: —40 +950° F or Equivalent in °C.

**C—INDUSTRIAL THERMOMETERS:** Red-Reading Mercury—Extruded brass case—chrome finish. Ranges: —40 +950° or Equivalent in °C.

**D—RED-READING MERCURY LABORATORY THERMOMETERS:** Thoroughly annealed for permanent accuracy. Complete line A.S.T.M. and fractional division types.

FOR COMPLETE INFORMATION WRITE FOR CATALOG

# PALMER

**PALMER THERMOMETERS, INC.**
Cincinnati 12, Ohio • MElrose 1 1500

This WHEEL

MAKES LEHIGH I. E. INDUSTRIAL FANS IDEAL FOR TOUGH INDUSTRIAL EXHAUST APPLICATIONS

Handles dust-laden air and gases, paper shavings and the like without clogging

Lehigh Industrial I.E. Fans . . . featuring heavy duty, unique channel construction, all-welded mild steel wheels of the long shaving design . . . solve difficult exhaust problems because of their non-clogging characteristics. They incorporate a universal housing, which permits rotation and discharge to be modified to facilitate variable field conditions.

**A complete range of sizes** is available in both 70° to 250°F and 251° to 600°F construction. All standard drive arrangements are available and will be furnished according to your specifications.

**Rugged, air-tight construction:** the fan housing is welded on the inside with a continuous fillet weld. This provides gas-and air-tight housing with joints of maximum strength.

**Standard, self-aligning ball-bearing pillow blocks** . . . grease lubricated . . . are featured on all Lehigh Industrial I.E. Fans.

**Optional accessories** include an inspection door, inlet and outlet flange, heavy duty housing construction, and drain plug.

**Get detailed information** on how Lehigh I.E. Industrial Fans can solve your industrial exhaust problems with dependable non-clogging performance. Your Lehigh Representative will be happy to supply you with full details. Or, if you choose, write directly to us for Bulletin L-5: 2172 LF-2

*"See Chemical Engineering Catalog for details and specifications".*

**LEHIGH FAN & BLOWER DIVISION**
**FULLER COMPANY, CATASAUQUA 1, Pa.**
Subsidiary of General American Transportation Corporation

LEHIGH


## RECENT TRADE LITERATURE

*Continued*

### Plastic Pipe

Eight page bulletin PA-1 is a selection guide for firm's five types and 15 variations of plastic pipe. Discusses factors of fluid, pressure, and temperature. Lists resin, general characteristics, pressure rating, available sizes, standards met or exceeded, and typical applications. Also includes a chemical resistance chart that lists 175 chemicals alphabetically and the resistance of each type of firm's pipe to them. — *Crescent Plastics, Inc., 955 Diamond Ave., Evansville, Ind.*

### Air Conditioners

Four page bulletin 2001 describes units for crane cabs, pulpits, and areas having high ambient temperatures. Units cool, dehumidify, remove dust, absorb fumes and gases, and heat. Illustrated with photos and dimensional drawings. — *Correct-Air Corp., Willoughby, Ohio.*

### Semi-Steel Valves

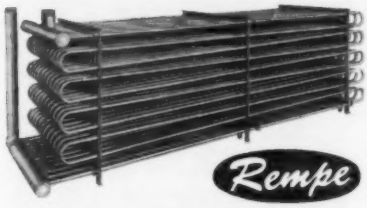
Forty-four page bulletin V-203 describes all sizes of semi-steel straightway, steam jacketed, multiport, and special order valves. Describes accessories including wrenches, locking devices, extensions, and lubricants. Gives complete specifications, photos, and dimensional drawing on each unit described. Series of line drawings show port and stop arrangements for multiport valves. — *Rockwell Manufacturing Co., Nordstrom Valve Div., 390 N. Lexington Ave., Pittsburgh 8, Pa.*

### Potentiometer Indicator

Four page catalog 64-1 describes 3½ lb portable unit for temperature measurement. Accuracy is ¼ of 1 percent of scale. Gives construction, application, and operational data. Lists accessories and specifications. Illustrated with line drawings and photos. — *Thermo Electric Co., Inc., Saddle Brook, N.J.*

REMPE
Heat Transfer Equipment

PIPE COILS
Custom Engineered to Your Requirements




HEAT RECLAIMING UNIT
Typical of the many varieties of coils produced by Rempe from any type of ferrous or non-ferrous pipe and tubing.
Coil illustrated is 15' long with 5" copper headers. Used in floor pit for reclaiming heat from waste process water to preheat boiler feed water. Ideal for reclaiming heat from any hot waste liquid and reducing fuel cost.

*Tell us your problem*
*We'll design the coil*

HEAVY DUTY
STEAM COILS
Distributor Type

Tilted feature assures drainage of condensate whether used for vertical or horizontal air flow.

Non-Freeze Design

Every square foot of face area produes equal heating capacity on full or modulated steam supply. Suitable for pressures to 200 lb. gauge.

Two row or one row available. Can be furnished with connections as shown or on opposite end of coil.

*Write for Details*

Rempe

*Engineering Data Book*
Pipe Coil and Fin Coil Designs. Heat Transfer Coefficients. Get a copy for your library.

REMPE COMPANY
342 N. Sacramento Blvd. • Chicago 12, Ill.

## RECENT TRADE LITERATURE
*Continued*

### Pipe Dimension Chart

A 17 × 11 pipe dimension chart shows outside diameter and wall thickness for all sizes of pipe from ½ through 42 in. Includes information from ASA Standard B36.10, showing IPS and schedule numbers and their relationships, and incorporates latest wall thicknesses added in the 1959 revision. Suitable for desk or wall mounting. — *Midwest Piping Div., Crane Co., P. O. Box 433, St. Louis 66, Mo.*

### Bronze Valves

Sixteen page pocket-size reference booklet No. 1496-V gives condensed listing of standard and low pressure gate, globe and angle, check, and special bronze valves. Includes a valve comparison chart and a section on "Do's and Don'ts of Valve Installation." Illustrated with line drawings and photos. — *Ohio Brass Co., 380 N. Main St., Mansfield, Ohio.*

### Insulation Adhesives

Four page catalog describes insulation adhesives, and separate catalog sheets describe lagging adhesive and lap sealing adhesive. Lists in table form: adhesive; recommended use; how to apply; bonding time; color; temperature limits; solvent; coverage in sq ft per gal; viscosity; approximate weight per gal; approximate solids; and flash point. — *St. Clair Rubber Co., Adhesives Div., 107 Clifford St., Detroit 26, Mich.*

### Fan Performance

Revised charts 50Cla give performance ratings for all standard sizes of firm's air handling, multizone, and heating-ventilating units. Charts plot performance of forward and backward curved fans for ½ through 6 in. SP in the range of 400 to 800 fpm. — *Recold Corp., 7250 E. Slauson Ave., Los Angeles 22, Calif.*

Babbitt
*Adjustable*
SPROCKET RIM
*with Chain Guide*
Changes that Danger Zone to a
SAFETY ZONE

—enables you to
ADD PLANT AREA

If re-aligning equipment will yield more working space, better production, lower costs—do it now. Save all space wasted for placing ladders to reach overhead valves. At the same time, convert Danger Zones to Safety Zones. Equip every overhead valve wheel in your plant with Babbitt Adjustable Sprocket Rims with Chain Guides.

- They simplify pipe layout.
- They fit any size valve wheel.
- They are easy to install and operate.
- They operate any valve from the floor.
- They save time and money.
- The first cost is the only cost (no maintenance).
- They are packed completely assembled (one to a carton), with easy-to-follow instructions.
- A hot-galvanized rust proof chain is available for all sizes.

Babbitt Adjustable Sprocket Rims with Chain Guide are carried in stock by most mill supply houses. Just phone your mill supply salesman or contact us direct.

Babbitt
108-B
STEAM SPECIALTY CO.
8 BABBITT SQUARE, NEW BEDFORD, MASS., U.S.A.

Install Insulation with

**TUFF-BOND**

Super-Strength Adhesives

***TUFF-BOND #7***
... fire-retardant adhesive for installing insulation

***TUFF-BOND M-102-H***
... duct liner adhesive

***TUFF-BOND 21-C***
... clear lap sealer and lap adhesive

***TUFF-BOND 21-W***
... white lap sealer and lap adhesive

***TUFF-BOND #6***
... non-flammable fire-retardant duct liner adhesive; meets Interim Federal Standard #00136.

***TUFF-BOND #9***
... for bonding rigid and semi-rigid plastic foams (polystyrene, urethane, isocyanate, etc.) to themselves and to other materials.

***TUFF-BOND #12***
... high pressure duct sealer

***TUFF-BOND QUIK SET***
... neoprene-base, fast-setting adhesive. Recommended for installing metal and nylon hangers to smooth surfaces.

***TUFF-BOND GENERAL PURPOSE IMPROVED***
... all-around adhesive for installing insulation, insulation hangers, etc.

*Ask for literature and prices.*

GOODLOE E. MOORE
INCORPORATED
DANVILLE 26, ILLINOIS

## RECENT TRADE LITERATURE
*Continued*

### Centrifugal Pumps

Two page bulletin 1051-1 describes seal-less, centrifugal pumps for pumping corrosive, toxic, explosive, radioactive, and other problem fluids over a wide range of temperatures and pressures. Gives general and model specifications, application data, and construction features. Illustrated with photos, tables, and graphs. — *Fostoria Corp., Chempump Div., Huntingdon Valley, Pa.*

### Pump Motors and Drives

Twenty page bulletin F-2002 is indexed so that pump motors and drives can be identified as to construction type (solid shaft, hollow shaft, submersible, horizontal, close-coupled, right angle geared drives, extended base, and others); as to enclosure (weather protected, drip-proof, totally-enclosed, explosion-proof, sealed, and weatherproof); and as to thrust (high, medium, normal). Illustrated with photos, tables, and line drawings.—*U.S. Electrical Motors Inc., P.O. Box 2058 Terminal Annex, Los Angeles 54, Calif.*

### Oil Fired Unit Heaters

Eight page catalog UH describes units with up to 180,000 Btu per hr outputs. Contains specifications, photos of typical installations, instructions, piping arrangements, and other information. — *PowRmatic Inc., 400 Commercial Ave., Palisades Park, N. J.*

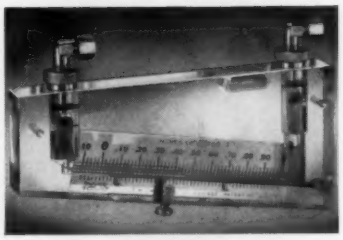
### Pressure Regulators

Twelve page bulletin describes direct and reverse acting pressure regulators, and control valves. Gives operation data, specifications, sizes, and a typical installation of both the direct and reverse acting types of regulators. Also includes flow coefficients for sizing valves for water and steam. — *Manning, Maxwell & Moore, Inc., Stratford, Conn.*

**FILTER EFFICIENCY**

*at a glance...*

**ANYTIME!**



Dwyer

# AIR FILTER GAGE

With the Dwyer Air Filter Gage you can be sure of maximum filter efficiency because you know the *exact* time to replace filters, *every time.* Gives a continuous, accurate check that spots inefficient filters, yet prevents waste through premature replacement.

The Dwyer measures filter efficiency the only practical and economical way—via pressure drop. Quickly pays for itself through savings in replacement and service time and greater operating efficiency.

Break-proof plastic construction, lifelong accuracy, simple installation, no moving parts to ever wear out or get out of adjustment. Ranges 0-½", 0-1", 0-2" and 0-3" water. A complete unit with all necessary tubing, fittings, etc.

*Write for Bulletin C10*

**F.W. DWYER MFG. CO.**
P. O. Box 373-H • MICHIGAN CITY, IND.

## RECENT TRADE LITERATURE

*Continued*

### Testing Air Cleaners

Two page bulletin B-5210 explains why the soiling effect of air is a useful index to its dust content and how this index is used to determine the efficiency of air cleaners in the U.S. Bureau of Standards Dust Spot Test. One side of the publication discusses details of how the efficiency of all types of air cleaners is measured by the test. The other side makes references to other of firm's booklets on various aspects of electronic air cleaning. — *Westinghouse Electric Corp., Sturtevant Div., Damon St., Hyde Park, Boston 36, Mass.*

### Valve Material Ratings

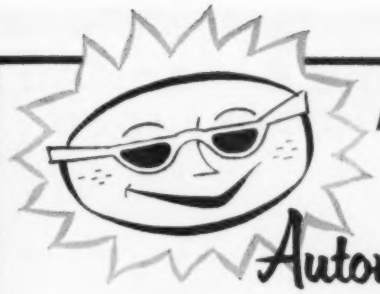
A quick-reference chart 593 shows pressure-temperature ratings for materials used in steel valves. Chart is a condensed version of ASA B16.5-1957. Includes standard ratings for the 300 to 2500 psi pressure classes. Can be hung on wall or placed under glass desk top. — *Lytle Engineering Specialties, Ltd., 438 St. Peter St., Montreal, Quebec, Canada.*

### Room Air Conditioners

Twelve page catalog AC201 describes units with face and by-pass damper control that keeps both temperature and air circulation constant. A single damper blade directs the flow of air either through or around the coils as needed. Catalog gives application data. — *Airtherm Manufacturing Co., P. O. Box 7039, St. Louis 77, Mo.*

### Combustion Control Systems

Twenty page bulletin 1002 describes all equipment necessary for a complete combustion control system. Includes oxygen analyzers, flow meters, draft gages, control valves, interlock switches, and flame safeguard equipment. — *Reliance Instrument Div., Electro-Mech Corp., Norwood, N. J.*

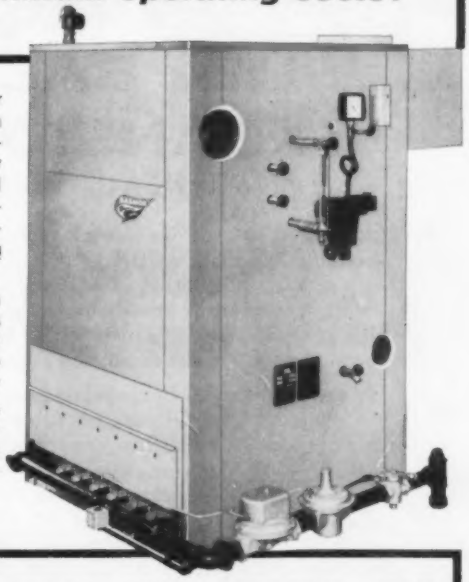



Rely on dependable
BASMOR
Automatic Sunshine
to meet big heating demands!

**AUTOMATIC SUNSHINE** is radiant hydronic heating with a Basmor Boiler. The healthful even, sun-like warmth of heat by radiation, whether from radiant baseboard, panels, convectors or conventional radiators.

**Basmor Gas-Fired Boilers** in sizes to meet commercial, institutional and industrial heating demands efficiently and economically. For all steam, hot water or vapor systems, and large volume water heating by the indirect method.

engineered for fast installation, simplified servicing, minimum operating costs!



**Basmor 400 Series** (Water Boiler shown above) in ten sizes from 375,000 to 1,050,000 BTU input. Top combustion efficiency with cast drill port burners and finest controls. Maximum utilization through patented "staggered heat travel" cast iron section design.

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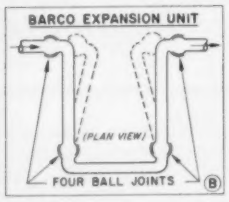
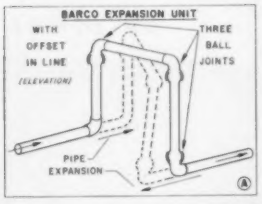
Basmor-Little Boilers, Furnaces, Gas Heaters, Water Heaters, Incinerators

# Handling Pipe Expansion in Long Outdoor Lines

**PROBLEM**—At this plant in Arkansas, asphalt at 500°F is pumped from refinery through approximately 1,300 feet of steam traced 6" insulated steel pipe. Heating of the piping causes a considerable increase in length. The problem of calculating movement and making proper allowance for this pipe expansion was complicated by the fact that the piping runs at various angles and elevations. *(See ANSWER below.)*




These schematic diagrams from Barco Bulletin 31A explain the accompanying photos.

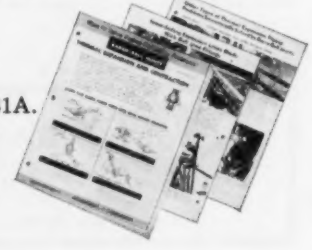


## BALL JOINT EXPANSION UNITS

***(NO REACTIVE FORCES)***

**ANSWER**—Barco Ball Joints solved the "pipe expansion" problem SIMPLY, ECONOMICALLY, EFFECTIVELY. No complicated calculation of stresses was required—Barco Ball Joints (see arrows) provide *points of flexibility.* In offsets (A), three joints allow for expansion; or four joints (B) are used to form a minimum size expansion loop.

Rugged "Fire-Safe" Barco joints have no thin wall sections, no critical points of fatigue, no rubber seals. They develop no "end thrust"... *no reactive forces;* require no expensive anchoring. They are ideal for steam and all kinds of fluids, including asphalt. Choice of styles and sizes ½" to 16" to meet your requirements. SEND FOR BARCO BULLETIN 31A.



**BARCO MANUFACTURING CO.**
541H Hough Street, Barrington, Illinois
In Canada: The Holden Co., Ltd., Montreal


## RECENT TRADE LITERATURE

*Continued*

### Air Diffuser

Eight page catalog CLD-70 describes air diffuser for troffers. Permits coordination of air distribution and illumination in a single ceiling unit. Gives selection data, dimensions, performance data, ceiling applications diagrams, specifications, and installation instructions. Illustrated with line drawings, photo, and table. — *Anemostat Corp. of America,* 10 *E. 39th St., New York* 16, *N.Y.*

### Bimetal Disc Thermostats

Four page bulletin 3000-1 describes thermostats for electronic and other applications. Covers both hermetically sealed and semi-enclosed styles. Gives full dimensional details, ranges, tolerances, differentials, ratings, and applications. Illustrated with photos, cutaway sections, and line drawings. — *Stevens Manufacturing Co., Inc., P. O. Box* 1007, *Mansfield, Ohio.*

### Cube Air Filter

Four page bulletin B1 describes cube type replacement filter for use in air conditioning, heating, air handling, and processing systems. Lists the face area, depth, capacity, and resistance of over 12 filter sizes. Gives instructions on installation, efficiency curves, and pressure drop tables. Illustrated with photos and graphs. — *Union Carbide Development Co.,* 270 *Park Ave., New York* 17, *N. Y.*

### Commercial Glasses

Sixteen page bulletin B-83 gives information on the mechanical, electrical, and optical properties; thermal stress; heat transmission; and viscosity of 32 commercial glasses. Revised edition includes expanded data on corrosion resistance, thermal expansion, and other factors. — *Corning Glass Works, Corning, N.Y.*

## RECENT TRADE LITERATURE

*Continued*

### Electronic Controls

Four page bulletin 141-61 gives detailed instructions, fully illustrated, for proper wiring of the units which make up various electronic control sets. Includes wiring diagrams, descriptions of control sets, information on proper installation of photocell holders, and data on the use of the microampere meter for photocell testing. — *The Carlin Co.*, 912 *Silas Deane Hwy., Wethersfield* 9, *Conn.*

### Chimney Protective Coating

Six page brochure No. SF describes protective coating to resist acid corrosion from high sulfur fuels in brick, steel, and concrete chimneys. Consists of charts showing testing methods and results of "Stackfas" as compared to conventional coatings; scaled graphs of various types of chimney construction and firm's method of protection; and application photos. — *Benjamin Foster Co.*, 4635 *W. Girard Ave., Philadelphia* 31, *Pa.*

### Cushioned Clamps

Two page bulletin No. 216G describes the use of "Teflon" as an insulating material for cushioned clamps. Illustrates a variety of shapes and styles of wire harness and tube supporting clamps along with a completely dimensioned line drawing of a loop type clamp. Includes a chart of the physical characteristics of "Teflon" for evaluation to specific applications. — *TA Manufacturing Co.*, 4607 *Alger St., Los Angeles* 39, *Calif.*

### Flexible Polyethylene Pipe

Form No. HM-1 covers all characteristics of flexible polyethylene pipe including physical properties, life-test performance, chemical resistance, installation features, and fittings. — *Carlon Products Corp., P.O. Box* 133, *Aurora, Ohio.*

ROBVON BACKING RINGS APPROVED FOR WELDING PIPE, VALVES AND FITTING JOINTS

Robvon's Commercial Backing Rings are designed for quick easy alignment of pipe or tubing and assure precise close tolerance fit-up. Robvon Backing Rings allow complete penetration and fusion of the weld. Robvon Backing Rings radiograph perfect certified welds. The patented nubs automatically set the welding gap for the root-pass. The internal bevel and flat inner land assures non-restricted fluid flow.

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FUEL OIL PUMP and HEATER SETS

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- Compact units save space.

EAGAN fuel oil pump and heater sets heat to 300° F, pump to 400 psi and have capacities to 3000 gph. Single or duplex units are available for steam or electric drive. Duplex "electro-steam" sets provide for electrical failure by incorporating one steam pump and one electric motor driven pump. Other EAGAN sets can be made to your special requirements.

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Mfrs. of condensate, boiler feed, turbine, centrifugal and proportioning pumps and fuel oil pump and heater sets.

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## RECENT TRADE LITERATURE

*Continued*

### Cooling Towers

Brochure describes 13 cooling towers in 5 to 80 nominal ton capacities. Heavy duty, centrifugal, draw-through types with galvanized steel frame, panel, decking, and eliminator construction. Gives selection and performance data. Tables chart such factors as entering and leaving tower water temperature; water flow gpm; and nominal capacity in tons of refrigeration. Physical dimensions, fan, motor, cfm, valve, and other data presented in graph form, keyed to cross-section on diagrams. Presents visual sketches of unit arrangement, both right and left hand. — *Drayer-Hanson Div., Hi-Press Air Conditioning of America, Inc., 3301 Medford St., Los Angeles 63, Calif.*

### Unions, Union Fittings

Sixteen page catalog supplement describes unions, elbows, and tees. Gives data on specifications, designs, weights, and dimensions. Illustrated with photos, tables, and line drawings for each basic unit described. — *Stockham Valves & Fittings, P.O. Box 2592, Birmingham 2, Ala.*

### Valves

Sixteen page catalog 10-B describes bronze, iron body and cast steel gate, globe and angle, and check valves; bar stock valves; and forged steel valves. Illustrated with photos and tables. — *R-P&C Valve Div., American Chain & Cable Co., Inc., Reading, Pa.*

### Thermostats

Four page bulletin 3000 describes snap-acting, fixed-temperature thermostats. Gives information on available terminals, mountings, ranges, ratings, and differentials. Construction, application, and operational data also included. Illustrated with photos, line drawings, and tables. — *Stevens Manufacturing Co., Inc., P. O. Box 1007, Mansfield, Ohio.*

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*Enhance the Beauty of Building Skylines*

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Lowest Silhouette Design

Forward or Backward Curve Wheel Within . . . . or Out of Scroll Housing

Motor mounting on side of structure support . . . out of line of air stream reduces height of Lo-Boy models nearly 50% of older designs.

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AMMERMAN CO., INC.
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P.O. Box 182
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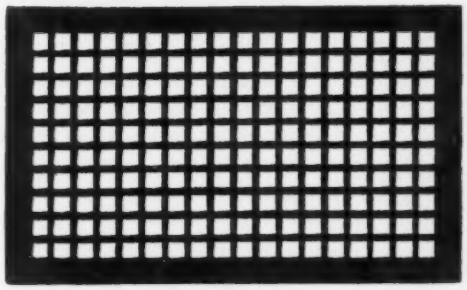
## Architectural Grilles for every type of installation



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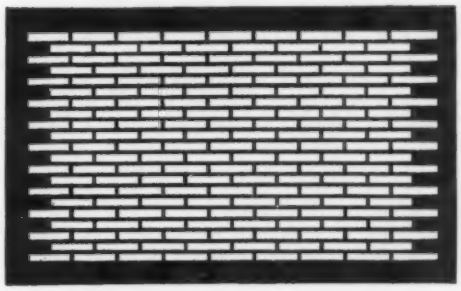
**57% Free Area**



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Getting exactly what you want is no problem when you specify A-J Architectural Grilles. There are practically no limitations on size and grilles can be made to your exact order from steel, aluminum, bronze, monel or stainless. Available in slotted designs B, C, and D, and square meshes of 1/2", 5/8", 3/4", and 7/8".

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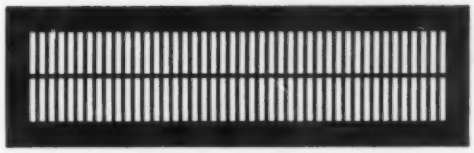

**NEW FROM A-J! Design E Convector-type grille with vertical pencil-proof slots for cooling or heating outlets, return or exhaust application. Free area 54%. May be installed in sills, sidewalls, ceilings or floors. Available in steel, aluminum, stainless or bronze.**

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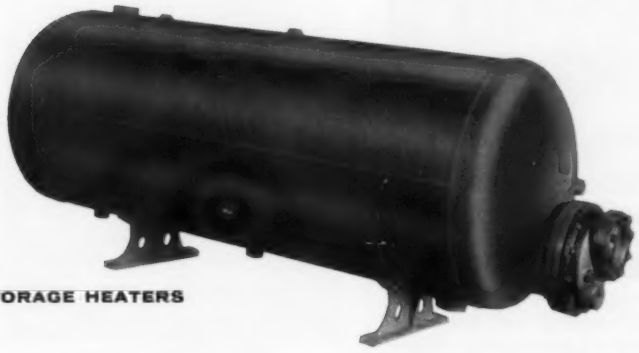
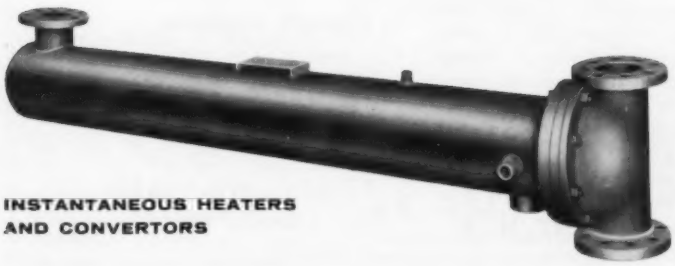


**STORAGE HEATERS**



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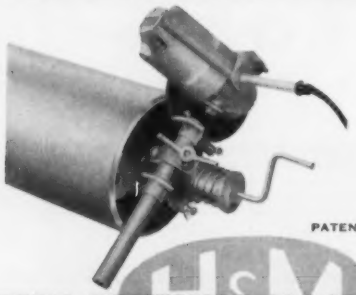
**and we'll know you're interested in finding out more about the H & M "BEVEL-LAND" Grinder. The "BEVEL-LAND" Grinder eliminates time-consuming handwork and assures better quality welds by accurately placing the land on the bevel. The grinder is electric or air powered and is available in two models — one for 6 to 12 inch pipe and one for 14 to 30 inch pipe. Larger models are available on request.**



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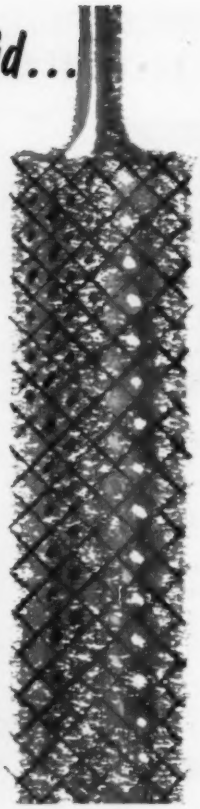



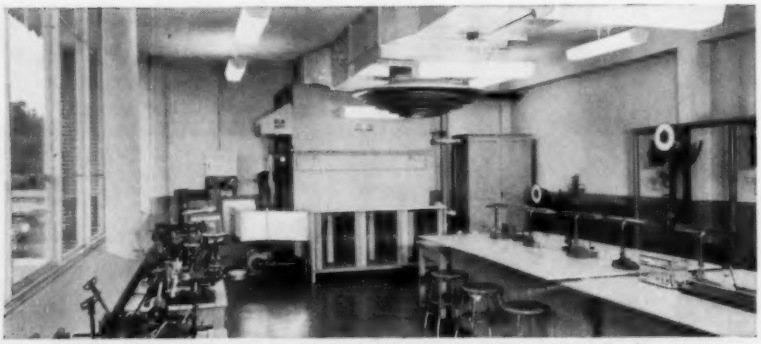

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NIAGARA Type "A" air conditioners assure that you actually realize all the benefits of precise atmospheric conditioning in your testing laboratory, your "clean room" or in your processing of hygroscopic materials.

This assurance; temperatures controlled to a fraction of a degree, relative humidity held to within 1%, results because this unit, exclusively, can provide saturated air in such compact space. Its extra capacity absorbs sudden peak loads. You hold your standard conditions continuously, without interruption. With its simple, inexpensive control you can vary your standard at will and reach the new condition quickly. Its range, using the Niagara "No-Frost" liquid below the freezing point of water, is through 140° F. Its reliability is proven. Service records show many machines still precise in operation after 20 years' service.

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**NIAGARA BLOWER COMPANY**
**Dept. HP-7, 405 Lexington Ave., New York 17, N. Y.**
*District Engineers in Principal Cities*


## RECENT TRADE LITERATURE
*Continued*

### Power Roof Ventilators

Eight page bulletin DB3-100 describes propeller fan power roof ventilators. Supersedes firm's previous bulletin on subject. — *Ilg Electric Ventilating Co.*, 2850 *Pulaski Rd., Chicago* 41, *Ill.*

### Threadless-Spindle Clamps

Four page bulletin describes high tensile strength aluminum threadless-spindle clamps. Three types available: standard frame; welding; and deep-throat types. Lists complete range of sizes, spindle types, and materials. — *United Associates*, 1605 *N. Hercules Ave., Clearwater, Fla.*

### Cloth Tapes

Twelve page brochure describes pressure-sensitive and heat sealing cloth tapes. Gives specific qualities, features, and applications. Tape dispensing equipment included. Illustrated with photos of applications. — *Permacel, New Brunswick, N.J.*

### Graphical Symbols Guide

Twelve page pocket-size guide of graphical symbols for piping, fittings, and valves in air conditioning and heating. Printed on heavy paper stock. — *Anaconda Metal Hose, Dept. GR, P.O. Box* 791, *Waterbury* 20, *Conn.*

### Masonry Anchoring

Eight page booklet, *Install It for Less*, is a guide to masonry anchors and anchoring methods. Explains selection factors for each job, types of anchors, and cost comparisons. — *The Rawlplug Co., Inc., New Rochelle, N.Y.*

## RECENT TRADE LITERATURE

*Continued*

### Preheating and Stress-Relieving

Thirty-two page booklet 400 *Cycle Induction Heating* EW-249 answers many of the questions about why, when, and what to preheat and stress-relieve. Includes sections on: demand for stress-relieving; program of stress-relieving; types of post-heat treatments for welded joints; preheating before welding; methods of stress-relieving; frequencies for induction heating; controlled programming; definitions and references; typical stress-relief treatments for certain ferrous alloys; stress-relieving as specified in "Rules for Construction of Unfired Pressure Vessels" from the ASME Boiler Construction Code; induction heating coil construction; attaching thermocouples; how to repair a thermocouple; and a trouble shooting guide. — *Hobart Brothers Co., Hobart Square, Troy* 1, *Ohio.*

### Central Station Air Handling Units

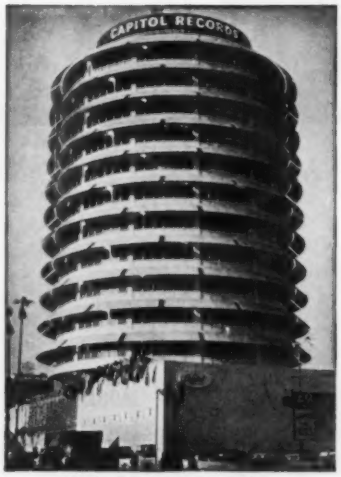
Four page bulletin describes central station air handling units for up to 20 separate and individual zones. Available in 11 sizes from 1200 to 36,000 cfm with both horizontal and vertical discharge. Features low and medium pressure; five types of coils; four types of filters; and three types of humidifiers. Ceiling suspension is available. Bulletin includes specification data, list of accessories, and physical data. —*York Corp., Grantley Rd., York, Pa.*

### Differential Pressure Regulators

Two page bulletin describes units for controlling the pressure of atomizing steam at an adjusted value higher or lower than the fuel oil pressure. Spring-loaded, diaphragm-operated valves are available in sizes from ½ to 2 in. inclusive. Includes methods of installation, operation, mechanical drawings, and dimension tables. — *Atlas Valve Co.,* 280 *South St., Newark* 5, *N.J.*

### Test Gages and Gage Testing Equipment

Eight page bulletin 363 describes laboratory test gages, master reference gages, dead weight testers and test pumps, pocket and vacuum test gages, and inspectors' test sets. Illustrated with photos and tables. — *Manning, Maxwell & Moore, Inc., Stratford, Conn.*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Completely Silences your piping system! CENTER-GUIDED, SHOCK PROOF, NOISELESS, ELIMINATES WATER HAMMER. FULL RADIAL FLOW. FACTORY MUTUAL LABORATORIES APPROVED.

SIZES 1" THROUGH 24"

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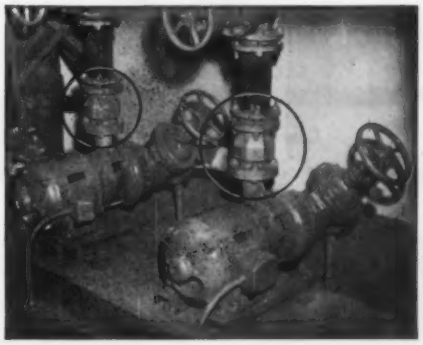

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**MILLER VALVE CO., INC.**

Pittsburgh 30, Pa. Plant—1620 Pennsylvania Ave.

## RECENT TRADE LITERATURE

*Continued*

### Heating and Cooling Load Calculating

Ninety-four page manual is part of three-element load estimating package that also includes a companion pad of 50 estimation forms and a psychrometric chart. Such data as glass, shading, and latitude factors are combined in tabular form. Summer load factors are combined in a single table for each principal kind of window glass. Similar tables cover glass blocks, walls, roofs, ceilings, floors, partitions, people, appliances, and ventilation air. Includes appendix tables on such items as simplified air volume calculations, heat removal, building materials lag, and shade factors. Manuals are $2 each; pads of estimation forms, 50 cents; and psychrometric charts, 25 cents. — *Arkla Air Conditioning Corp., 812 Main St., Little Rock, Ark.*

### Pressure Vacuum and Compound Gages

Thirty-two page catalog RH-54 describes pressure vacuum and compound indicating gages. Units incorporate a helical roller. Various types of cases, dials, and movements such as bronze, steel, stainless steel, and K monel are discussed. Calibration and adjustment procedures are illustrated. — *Helicoid Gage Div., American Chain & Cable Co., Inc., 929 Connecticut Ave., Bridgeport 2, Conn.*

### Diaphragm Valves, Air Control Equipment

Four page bulletin describes straight-through valves for acids, oils, alkalis, slurries, and most hard-to-handle liquids. Units available in sizes from ½ to 14 in. and for pressures up to 250 psi, depending on size. Also describes air pollution control equipment such as scrubbers, washers, dust collectors, and fume eliminators. — *Automotive Rubber Co., Inc., 12585 Beech Rd., Detroit 39, Mich.*

### Interchangeable Process Pumps

Eight page bulletin 1-210 shows how 72 basic process pump combinations allow a choice of features for the service required. Illustrated with a series of exploded view drawings with interchangeable parts explained. — *Byron Jackson Pumps, Inc., Standard Products Div., P.O. Box 2017, Terminal Annex, Los Angeles 58, Calif.*


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Planned Performance*
forced draft TURBO-RING Burners

DELIVER THE HEAT at
low initial investment —
low operational cost —
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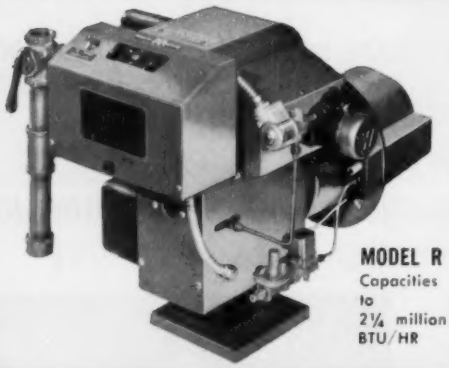

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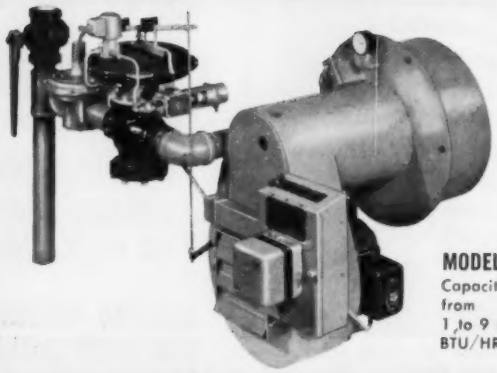
2¼ million
BTU/HR



MODEL FGR
Capacities
from
1 to 9 million
BTU/HR

Gas, oil or combination burner

TURBO-RING

Boilers equipped for pressure firing require no stacks . . . merely a vent

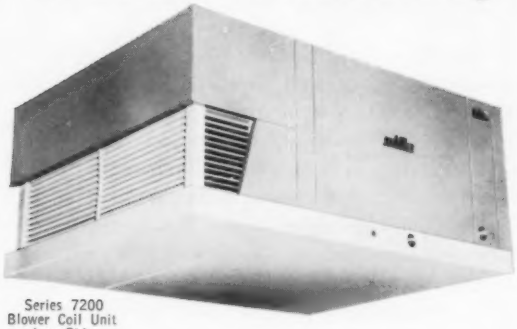
Gordon & Piatt, Inc.
P. O. Box 914
WINFIELD, KANSAS

Gordon & Piatt manufactures a complete line of combustion equipment: Atmospheric gas burners • Power gas burners • Control panels and burners for special applications.

*PLANNED — Factory assembled, pre-wired for "Bolt-on" installation.
*PERFORMANCE — Custom matched to individual boilers for quiet, efficient operation.

usAIRco

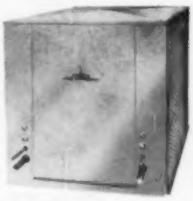
# Air Cooled Split Systems offer Greater Flexibility



Series 7200
Blower Coil Unit
Low Side

**BLOWER-COIL ASSEMBLY UNITS, Series 7200,** suited for horizontal air flow. May be installed in the space to be air conditioned or remote with duct work. Also available are vertical models for floorstanding application.

**AIR-COOLED CONDENSING UNITS, Series 8300,** designed for outside location, are horizontally proportioned to produce a low-sihouette for ideal on-the-roof installation.



Series 8300
AIR COOLED
Condensing Units
High Side

When the Series 8300 is used with its companion Series 7200, system capacities range from 31,000 BTU/hr to 208,000 BTU/hr (based on a condenser ambient of 95 degrees).

**USAIRCO** Split Systems, available in 6 sizes, open a tremendous new profit opportunity in shopping center, factory, bowling lane, variety, chain, restaurant, amusement and many other commercial and industrial applications. Get the facts today.

**Write for Bulletins 72B and 83B**

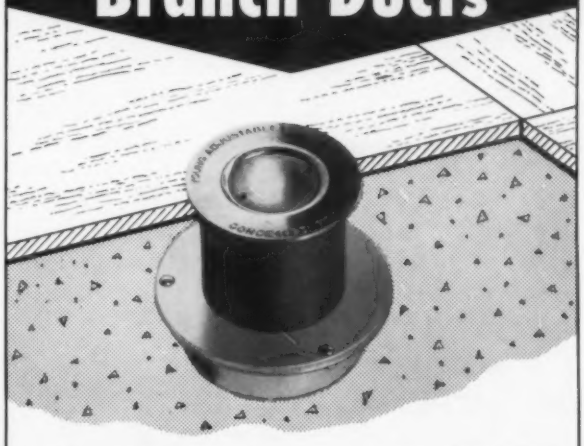
**United States Air Conditioning Corporation**

**DELAWARE, OHIO**

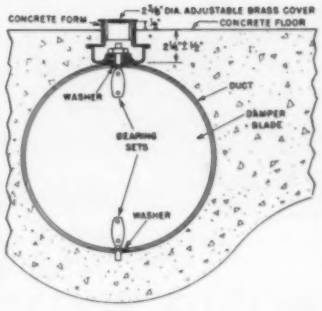


# For a better balanced Perimeter Heating and Cooling System - *install*

# YOUNG Floor Line Adjustable Cover Regulators in Branch Ducts



**Adjustable Brass Cover screws down flush with floor after form is removed.**




The Young No. 330 Regulator, installed in a branch duct, gives *accurate* control of the volume of air to the register.

This is the *sure way* of controlling the required volume of air for individual rooms.

Only 2-3/8" in diameter, the adjustable cover plate fits flush with the floor. Model No. 330 is for installations with up to 2" of concrete above the duct. Other models are available for up to 12" of concrete above the duct.

*Write for complete catalog or consult Sweet's Architectural File or the Engineer's Product File.*

**YOUNG REGULATOR COMPANY**

20910 Miles Parkway, Cleveland 28, Ohio

## WE HEAR THAT . . .

Robert A. Kroeschell, chairman of the board of *KROESCHELL ENGINEERING COMPANY*, Chicago mechanical contracting firm has announced the election of Hans A. Stade as president and treasurer. Mr. Stade succeeds Paul H. Kroeschell who died suddenly April 21, 1961 at sea enroute to Europe. Mr. Stade is one of the original directors of the company and has been executive vice president a number of years.

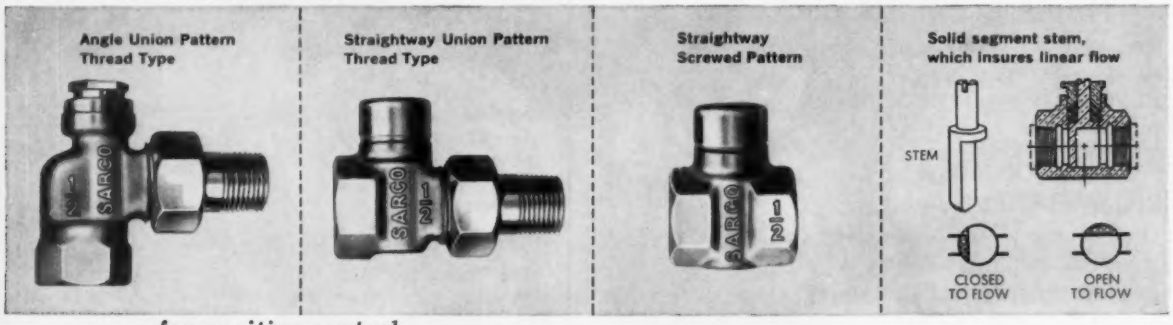
*SHELDONS MANUFACTURING CORP.* has leased a 12,000 sq ft plant at Bensenville, Ill. (less than 20 miles from Chicago) for the purpose of manufacturing a full line of fans, including centrifugal, vaneaxial, tubeaxial, and propeller models; and also pressure blowers, centrifugal compressors, and heating and cooling coils. *SHELDONS ENGINEERING, LTD.* of Canada designed and engineered the products. Initial production has already begun.

A new method for cold-forming pipe fittings was recently patented by the *SPEEDLINE CORROSION RESISTANT FITTINGS DIV.* of the *HORACE T. POTTS CO.* Features of the new method include allowance of 180 deg bends with assured wall thickness control. The firm was also selected by the U.S. Patent Office to exhibit the process in its 1961 Mechanical Exhibit.

The *AIR-CONDITIONING AND REFRIGERATION INSTITUTE* has formed a new Product-Section, to be known as the Non-Residential Warm Air Heater Section. Six member companies have already joined the new section, and additional members are considering joining.

*LYNCH CORP.* has acquired the "Coblentz" dry air systems from the *LOVELL MANUFACTURING CO.* The method used by this system is to draw in atmospheric air, chill it to 38 F, and shrink it to a high density so that the compressor delivers a greater weight of air per stroke. The air is simultaneously filtered and dehumidified.

*UNIVERSAL DIFFUSER CORP.* has moved its manufacturing plant into new and larger quarters occupying 40,000 sq ft in Yonkers, N.Y. Located at 155 Saw Mill River Road, the company has also expanded its line to include: extruded aluminum grilles; extruded & anodized aluminum multi-pattern diffusers; and a combination lighting troffer & diffuser. A complete testing laboratory is being installed for research, development, and demonstration. Development work is now in progress to produce a dual-duct mixing box line.


*for positive control*
*in balancing hot water systems, use* **SARCO**

**SOLID SEGMENT STEM BALANCING FITTINGS**

Sarco Balancing Fittings use a stem having a segment of a circle, instead of the butterfly stem on old type balancing fittings. Sarco construction gives you three solid advantages:

First, you get linear flow. Equal openings give you even throttling action and that can save you hours in balancing water systems. Second, when you set a Sarco fitting with this solid segment stem in the full open position you get no obstruction to flow. That means less pressure drop through the fitting. Third, Sarco balancing fittings are designed to operate perfectly to 200 psi maximum — cold liquid, non-shock.

**Available in both thread and sweat types**

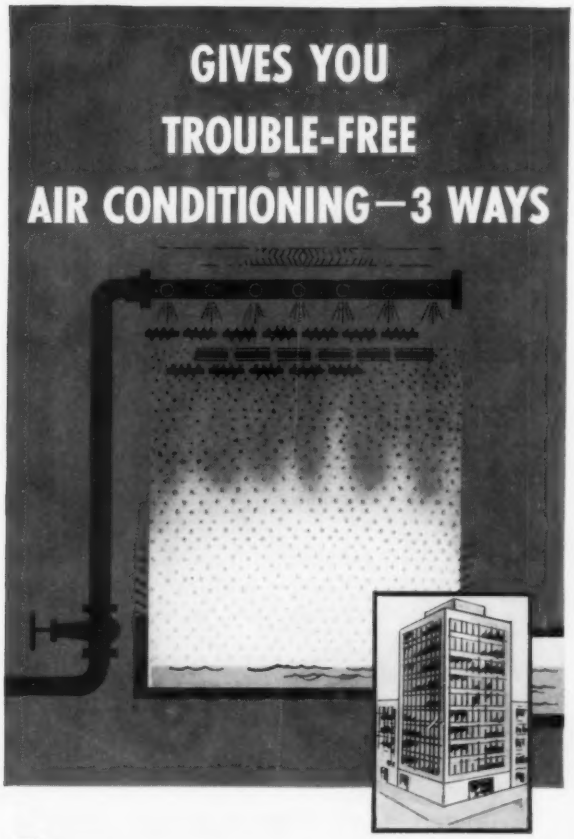
Sarco Balancing Fittings are available in both thread and sweat types, in all patterns. Also with integral air vents. Ready for prompt delivery, too: access boxes for balancing fittings; valves; air eliminators. Write for Bulletin. 7076

SARCO

SARCO COMPANY, INC.
AN AFFILIATE OF SARCOTHERM CONTROLS, INC.
615 MADISON AVENUE, NEW YORK 22, N. Y.
PLANT: BETHLEHEM, PA.

STEAM TRAPS • TEMPERATURE CONTROLLERS
STRAINERS • HEATING SPECIALTIES

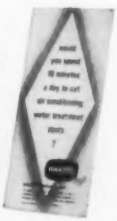
## Oakite Airefiner No. 52 in water




Properly treated water in air conditioning systems goes a long way in prolonging equipment life, improving operating efficiency and keeping systems trouble-free. A small amount of Oakite Airefiner No. 52 added to cooling tower water does all this—and more! A softening and purifying material, Airefiner No. 52:

1. Checks growth of pipe-blocking, jet-clogging algae and slime
2. Prevents build-up of insulating scale
3. Minimizes metal-eating corrosion

Try Oakite Airefiner No. 52 in your water system and see the difference in lower maintenance costs, more efficient cooling, less out-of-service time.



**THIS MAINTENANCE MANUAL** gives complete details on cleaning and maintaining air conditioning and refrigeration systems at less cost. For your free copy, write Oakite Products, Inc., 51B Rector Street, New York 6, N. Y.

SPECIALIZED INDUSTRIAL CLEANING
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MATERIALS · METHODS · SERVICE
SCIENCE

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## Drayer-Hanson Air Conditioning

**WORLD-WIDE!**

## 20 D-H FLOOR/CEILING-MOUNTED PUBLIC SPACE AIR HANDLERS

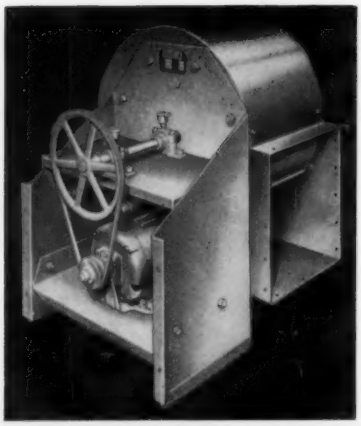
**CREDITS:** ARCHITECT: Charles F. McKirahan, Ft. Lauderdale, Florida. AIR CONDITIONING CONTRACTOR: Josueth Gonzalez, Quito, Ecuador. D-H INTERNATIONAL SALES REPRESENTATIVE: Climate Control International, Inc., Los Angeles

*Send for Brochure CSHV 312.01*

d-h HP

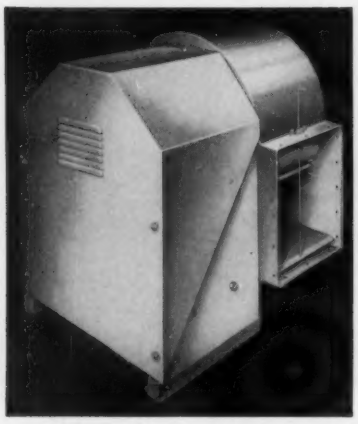
**drayer-hanson**

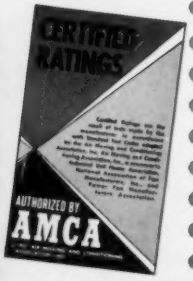
DIVISION OF
**HI-PRESS AIR CONDITIONING OF AMERICA, INC.**
3301 Medford Street, Los Angeles 63, California
(Cable: Cliconi, Los Angeles)



Aladdin
AIR HANDLING EQUIPMENT

UTILITY SETS






**TEN SIZES • COMPACT • BELT DRIVEN**
**SELF CONTAINED • QUIET OPERATING**

**ALADDIN Belt-Driven Utility Sets** are extremely quiet in operation. Designed for general ventilation, they occupy a minimum of space, handling large volumes of air at low noise levels. They are ruggedly built and are ideally suited for roof installation . . . when furnished with weatherproof cover they require no further protection against the weather.

ALADDIN Utility Sets are available with both forward curved or backwardly inclined blade wheels.

***Write for complete data***

**ALADDIN HEATING CORPORATION**
**1111 WEST AVENUE 137 • SAN LEANDRO, CALIFORNIA**

## WE HEAR THAT

*Continued*

*STANLEY ENGINEERING CO.* in Muscatine, Iowa, has been incorporated with no change in name. Directors of the firm are Max Stanley, Art Stanley, San Fosholt, Roy Vanek, and Frank Edwards.

*KAYKOR PRODUCTS CORP.* has purchased the *KAYKOR INDUSTRIES DIV.* of *KAYE-TEX MANUFACTURING CORP.*, and is now being operated as an individual company.

*RANCO INC.* has concluded an agreement with Nichiden Kogyo Co., Ltd. and associates for the formation of a new Japanese company on a joint venture basis to produce and market Ranco controls in Japan. The agreement is now subject to approval by the Japanese government.

*GENERAL FOAM CORP.* is expanding its facilities in Hazleton, Pa., by leasing a 68,000 sq ft building directly across the street from its existing plants.

*TESCOM CORP.* is the new name of the former Smith Welding Equipment Corp. Smith Welding Equipment will become a division of Tescom, as will a new Fluid Systems Div.

*NORTHWESTERN UNIVERSITY* has received a $648,161 grant to provide sharply expanded research facilities in bio-engineering and biochemistry at its Technological Institute. The grant was made by the National Institutes of Health, U.S. Public Health Service. Among the subjects to be researched, listed with their faculty researchers, are: atmospheric pollution, Jimmie E. Quon; and air hygiene, Burgess H. Jennings.

Glenn P. Bakken was re-elected president of the *COPPER & BRASS RESEARCH ASSSOCIATION* at the group's 39th Annual Meeting. Elected senior vice president was E. P. Dunlaevy.

*SIERRA ELECTRIC CORP.* has purchased all rights, inventories, and tooling for the low-voltage electrical control system currently produced by the *SQUARE D CO.* All engineering manufacturing equipment will be located in Sierra's Gardena, Calif. facility.

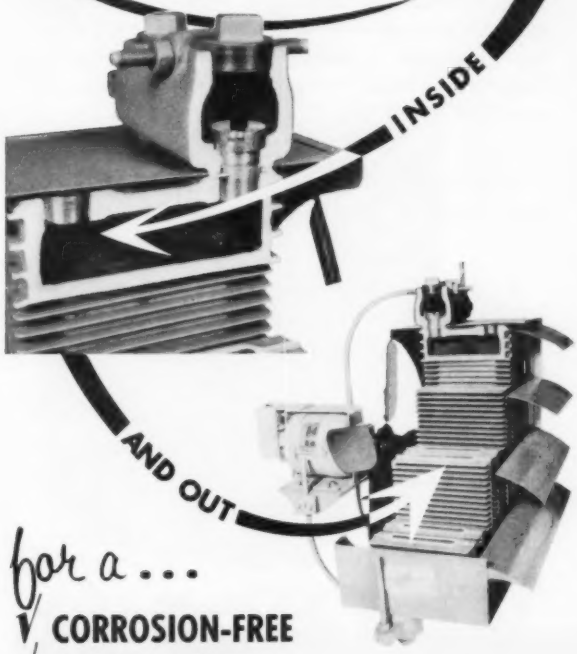
The *PENN METER CO.* has purchased the *PENN INSTRUMENT DIV.* of *BURGESS-MANNING CO.*

*MID-WEST DEVELOPMENT CENTER* is the new name of the former Mairco Div. of the *ROBERT-SHAW-FULTON CONTROLS CO.* The Center will be used exclusively for new product development.

...in

# GRID

*It's the material that makes the difference*




for a . . .

✓ CORROSION-FREE
✓ TROUBLE-FREE
✓ LOW-MAINTENANCE

**HEATING SYSTEM . . . GRID** Cast Iron Construction resists corrosion externally from acid fumes and internally from electrolysis. No leaking from rotted cores.

**GRID** one-piece cast iron heating sections and headers are leakproof on steam pressures up to 250 p.s.i. 450° temperature. Smaller steam lines cost less.

**GRID** heating sections with widely spaced fins cast integral with steam chambers are easy to clean — Will not "mat" on air intake side.

**GRID** design develops low outlet temperatures and with proper fan volumes, delivers warm, comfortable air to floor — No wasted heat at ceiling.

*ask* ASK for complete information on GRID Cast Iron Steam Heat Transfer Surface . . . write for catalog #956.

**INSTALL GRID CAST IRON**

UNIT HEATERS BLAST HEATERS RADIATORS

**D. J. MURRAY MANUFACTURING CO.**
Manufacturers Since 1883 • WAUSAU, WISCONSIN
REPRESENTATIVES IN ALL PRINCIPAL CITIES

# reliable liquid level or flow control

A **sleeve**, raised and lowered within a nonmagnetic tube by any suitable sensing means, as liquid level or flow rates change, attracts or releases a permanent magnet attached to a **mercury switch** outside the tube. That's all there is to it!

at practically any temperature or pressure

## MAGNETROL

The positive pull of a permanent magnet replaces all bellows, packing glands, diaphragms and electrodes — eliminates all wearing parts.

Magnetrols operate indefinitely to control the level or flow of virtually *any* liquid — at practically *any* temperature or pressure. They are so simple that only a simple change in component material is normally needed to adapt standard units to even the most unusual operating requirements. Of course, "special" Magnetrols can be developed to meet any specific plant need.

Magnetrols are available for controlling *liquid level* changes from ¼" to as much as 150' and more — with single or multi-stage switching; *flow switches* to signal start, stop or insufficient flow within fractions of gpm rates.

*Fill in coupon and attach to your letterhead for full information.*

18

**MAGNETROL, Inc.** 5322 Belmont Road, Downers Grove, Ill.
Please send me catalog data and full information on Magnetrol
☐ Liquid Level Controls ☐ Flow Controls

Name_____

## WE HEAR THAT

*Continued*

Frank W. Brandon has been named estimating manager of *LIMBACH CO.'s* mechanical department. He will direct all estimation of heating, air conditioning, ventilating, and plumbing in a three state area. The Limbach Co. is a mechanical contracting firm, with main offices in Pittsburgh, Pa.

Rixford A. Beals has been named manager of the Commercial & Industrial Div. of the *NATIONAL BETTER HEATING-COOLING COUNCIL.*

*ALBERT KAHN ASSOCIATED ARCHITECTS AND ENGINEERS, INC.* has elected the following directors: George H. Miehls, Sol King, Sheldon Marston, R. E. Linton, V. C. Wagner, G. S. Whittaker, and Paul G. Fleck. New officers elected by the Board for the coming year are: George H. Miehls, chairman and treasurer; Sol King, president; Sheldon Marston, executive vice president; R. E. Linton, V. C. Wagner, G. S. Whittaker, and Paul G. Fleck, vice presidents; and Louis Menk, secretary. The main office of this firm is in Detroit, Mich.

*PALL CORP.* and the *TRINITY EQUIPMENT CORP.* have been merged. Trinity will continue as a wholly owned subsidiary of Pall.

An 87,000 sq ft plant is being built by the *JAMESBURY CORP.* The plant is located on an 8½ acre site in Worcester, Mass., as the first building in a new industrial park.

The *FOXBORO CO.* has made an agreement with *WAUGH ENGINEERING CO.* to purchase the latter's assets in exchange for Foxboro stock. Waugh will be operated as a division of Foxboro. Foxboro has also recently opened a $700,000 assembly plant in East Bridgewater, Mass. Occupying 40,000 sq ft, the plant employs a staff of 150.

*WATUBO INDUSTRIES* is the new name of the former Water Tube Boiler & Tank Co.

A 13,000 sq ft addition has been completed by *JOSEPH T. RYERSON & SON, INC.* at its Seattle, Wash. plant. The building will be used for warehousing purposes.

*KAMWELD PRODUCTS CO.* is the new name of the former Kamlar Products Co.

*FMC CORP.* is the new name of the former Food Machinery and Chemical Corp.

Centridyne BY WESTERN
RATINGS
AMCA
The new compact centrifugal roof ventilator. Advanced styling as low as 11½"
WRITE FOR TECHNICAL INFORMATION
WESTERN ENGINEERING & MFG. CO.
P.O. Box 66455 • Los Angeles 66, California

# ELECTRIC HOT WATER HEAT

## TO 2,500,000 B.T.U. OUTPUT

# PRECISION

## ELECTRIC HOT WATER HEATING BOILER

**COMPLETE UNIT READY FOR INSTALLATION**
with circulation hot water system and water chiller for year-round air conditioning.

**CONVERSION EASILY ACCOMPLISHED**
where other type fuels now used. Suited for home, churches, motels, apartments, hotels, hospitals, commercial buildings, swimming pools, snow melting and domestic hot water for large users. Temperature range — 60 to 250 degrees. Equipped with Sequence and Proportional Controls when desired.

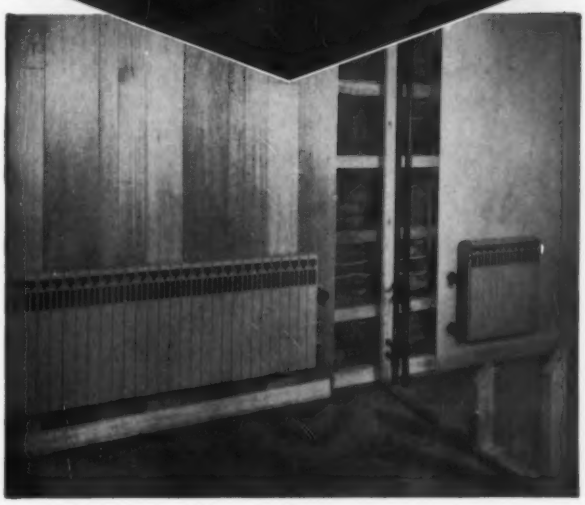
- **Every unit tested and inspected 40,948 to 2,500,000 B.T.U. Output.**
- **All Boilers meet the requirements of the ASME Boiler and Pressure Vessel Code. Natl. Board approved.**

**No chimney! No odors! No flame! No ducts! No noise!**

Write for complete specifications and prices

**PRECISION parts corporation**
**400-HPA NORTH FIRST STREET**
**NASHVILLE 7, TENNESSEE**

# REDUCE piping costs ... SPEED installation



## with SHAW Radiators

Only Shaw, of all modern radiators, offers *same end* as well as opposite end tapping. Same end tapping has a place in almost every piping layout, and its use invariably means less piping materials, simplified pipe fitting.

Important savings in installation time are made with *any* Shaw model, regardless of tapping arrangement. Shaw units are compact, fully self-contained assemblies only 3" thick, easy to handle and mount. There are no dampers, or separate housings to fit and install.

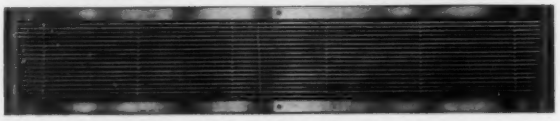
Shaw Radiators distribute both radiant and convected heat in unvarying, health-guarding proportions that create natural thermal comfort in a room. They use either hot water or steam up to 150 psi. Write today for free literature on both panel and baseboard models.

Shaw Baseboard and Panel Radiators feature heavy gauge steel heating fins and box-type exterior radiant panels snugly fitted around the heavywall copper tubing. Tubing is then expanded slightly by 3750# hydraulic pressure to hold all components as a rigid, self-contained unit. The tight metal-to-metal bond assures rigidity and full heat conduction.

**SHAW-PERKINS MANUFACTURING COMPANY**
201 East Carson St. • Pittsburgh 19, Pa

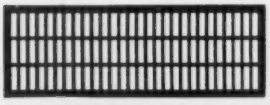
*In America's Finest Buildings...*

**LOOK BETTER... LAST LONGER!**

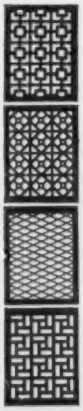


**DIAMOND FABRICATED GRILLES**

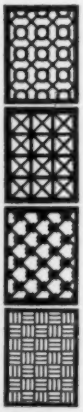
. . . meet the current demand for a very strong bar-type grille which provides more than the usual percentage of open area and is suitable, in general appearance, for use with practically any modern style of interior design. Specified by leading engineers and architects for Schools, Colleges, Hospitals, Ocean Liners, Sports Arenas, etc. Custom Built (no standard sizes) in any specified rectangular size or shape — All Steel or All Aluminum — for either direct or deflected air flow. Write for Bulletin 43.



**DIAMOND ARCHITECTURAL GRILLES**



. . . are stamped from Steel, Aluminum, Bronze or any other commercial metal; in a wide variety of artistic designs, in any desired thickness up to one-quarter inch, with correspondingly LARGE unit openings. Widely used, for nearly half a century, in America's finest buildings, they have proved practically indestructible — standing up for years against any probable amount of rough usage. Bulletin 41 illustrates and describes a number of popular designs and applications. Catalog 36 (100 pages) contains actual-size illustrations of ALL Diamond Grille designs, together with complete working data. Write for either or both — no charge or obligation.



**DIAMOND MANUFACTURING CO.**
**Box 41 WYOMING (Wilkes-Barre Area) PENNA.**


## WE HEAR THAT

*Continued*

Everett Elliott was elected chairman of the board of the *NATIONAL OIL FUEL INSTITUTE* at the first meeting of the board of directors of the new group. The same meeting approved the constitution and by-laws and short-term programs recommended by Glenn L. Werly, NOFI president.

The *STAMFORD FAN CO.* has been organized to manufacture and sell a line of commercial and industrial fans and blowers. Associated with the new company is *SEDGWICK MACHINE WORKS, INC.*, Poughkeepsie, N.Y. Research, design, and manufacturing of the new line will be conducted at the Poughkeepsie plant. Sales will be handled at the Stamford office, 47 Cedar St., Stamford, Conn.

*REPUBLIC-TRANSCON INDUSTRIES, INC.* has purchased the *THE MATHES CO.*, former division of *GLEN ALDEN CORP.*

George C. Briley has been named vice president and sales manager of *KERBY SAUNDERS, INC.*, New York City mechanical contracting firm. Mr. Briley will supervise sales in the fields of heating, piping, air conditioning, refrigeration, and plumbing in this country and abroad.

Carl W. Lemmerman has been named sales manager of the *ACOUSTICS AND INSTRUMENTS DIV., KORFUND CO.* Mr. Lemmerman has written articles for Heating, Piping & Air Conditioning.

## MEETINGS & CONVENTIONS

*JULY* 18-20 — *Western Plant Maintenance and Engineering Show & Conference.* Pan-Pacific Auditorium, Los Angeles, Calif. Information: Western Office, 759 Monadnock Bldg., San Francisco 5, Calif.

*JULY* 31-*AUGUST* 11 — *Tufts University Summer Institute for Technical Writers and Publishers.* Tufts University, Medford, Mass. Information: Mrs. Florence N. Trefethen, assistant director, 8 N. Hall, Tufts University, Medford 55, Mass.

*AUGUST* 14-18 — *UA International Apprentice Contest.* Purdue University, Lafayette, Ind. Information: United Association of Journeymen & Apprentices of the Plumbing & Pipefitting Industry of the United States and Canada, United Association Building, 901 Massachusetts Ave., N.W., Washington 1, D.C.

There's more ways than one to improve

DRAFT EFFICIENCY

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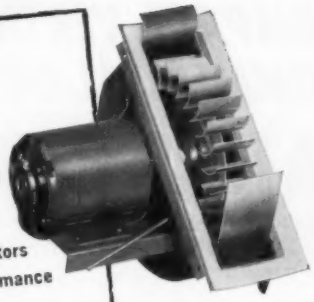
TJERNLUND

AUTO-DRAFT INDUCERS

- Vibration-free, quiet operation
- Heavy-duty, durable construction
- Simple installation
- Venturi-type operation
- Minimum space for mounting
- Nationally known motors
- Factory-tested performance
- Full range of sizes
- Light weight
- Doesn't rob furnace room of combustion air



The thousands of Tjernlund Auto-Draft inducers now giving trouble-free performance are proof of superiority. Write for literature and prices.

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MANUFACTURING COMPANY

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Cook ALL ALUMINUM VENTILATORS

THE FIRST VENTILATOR WITH A 5 YEAR WARRANTY

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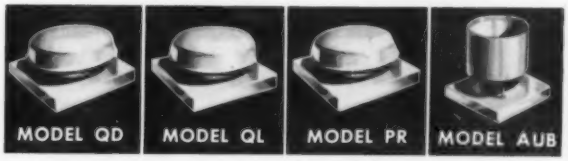
All these benefits have been proven by past performance and service—the justification for being the first ventilator to offer a 5 year warranty.

*See Sweet's Architectural File or send coupon for complete line catalog.*

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THE LOREN COOK COMPANY

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## MEETINGS & CONVENTIONS

*Continued*

*AUGUST* 21-31 — *International Exhibition of New Sources of Energy.* To be held concurrently with the *United Nations Conference on New Sources of Energy.* Circo Massimo, Rome. Information: Rassegna Internazionale Elettronica e Nucleare, Via della Scrofa, 14, Rome. (cable address: ROMATOM) Please mark correspondence: International Exhibition of New Sources of Energy.

*SEPT.* 12-14 — *Southeastern Maintenance and Engineering Show.* War Memorial Coliseum, Greensboro, N.C. Information: John Harden Associates, P.O. Box 3173, Greensboro, N.C.

*SEPT.* 25-28 — *American Welding Society Fall Meeting.* Adolphus Hotel, Dallas, Tex. Information: Information Center, American Welding Society, 33 W. 39th St., New York 18, N.Y.

*SEPT.* 27-*OCT.* 4 — *The Institute of Heating and Ventilating Engineers, International Conference on Heating, Ventilating and Air Conditioning.* London, England. Information: F. L. Rossetti, secretary, Conference Coordination and Management Committee, 49, Cadogan Sq., London, S.W.1.

*OCT.* 1-4 — *43rd Annual Meeting, American Gas Association.* Registration, Dallas Municipal Auditorium; various sessions at the Statler Hilton, Sheraton-Dallas, Adolphus, and Baker hotels, Dallas, Tex. Information: American Gas Association, 420 Lexington Ave., New York 17, N.Y.

*OCT.* 7-10 — *Western Building Industries Exposition.* Great Western Exhibit Center, Los Angeles, Calif. Information: Western Building Industries Exposition, 2216 S. Hill St., Los Angeles 7, Calif.

*OCT.* 9-11 — *Technical Committee on Cooling Water Problems, North Central Regional Meeting of National Association of Corrosion Engineers.* Chase Park Plaza Hotel, St. Louis, Mo. Information: Otto H. Fenner, Monsanto Chemical Co., 1700 S. 2nd St., St. Louis 4, Mo.

*OCT.* 16-17 — *International Conference on Air Ionization.* Franklin Institute, Philadelphia, Pa. Information: American Institute of Medical Climatology, 1618 Allengrove St., Philadelphia 24, Pa.

*OCT.* 16-20 — *National Safety Council Annual Convention.* Industrial sessions will be held in various hotels, Chicago, Ill. Information: National Safety Council, 425 N. Michigan Ave., Chicago, Ill.


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4 NEW MODELS

USES ANY TYPE GAS

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FULLY AUTOMATIC GAS-OPERATED
COMPACT VERTICAL TYPE
COMMERCIAL-INDUSTRIAL
WATER HEATERS & BOILERS

A Ewing Heater-Boiler ELIMINATES EXPENSIVE, SPACE-CONSUMING STORAGE TANKS. THE VERTICAL DESIGN ALSO SAVES VALUABLE FLOOR SPACE. Choice of 4 sizes for a multitude of uses.

Perfect for:

APARTMENT BUILDINGS, ATHLETIC PLANTS, BAKERIES, CHURCHES, BATH HOUSES, BARBER AND BEAUTY SHOPS, CLINICS, COUNTRY CLUBS, BAPTISTRIES, QUICK CAR LAUNDRIES, HOSPITALS, HOTELS, MOTELS, FOOD ESTABLISHMENTS, OFFICE BUILDINGS, SUPER MARKETS, LAUNDRIES OF ALL TYPES, CLEANING PLANTS, SERVICE STATIONS, INDUSTRIAL PLANTS AND MACHINE SHOPS, POULTRY PROCESSING PLANTS, ENGRAVING AND PLATING PLANTS, SWIMMING POOLS AND MANY OTHER USES.

All four models are built to specifications, meeting American Gas Association requirements, and are approved by its testing laboratories. Also tested and inspected in accordance with the rules of ASME Heater and Pressure Vessel Code. Each unit superbly engineered.

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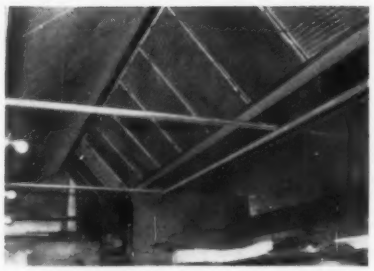
VORTOX AIR FILTERS



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Vortox grease filters, like Vortox dust filters, deliver top efficiency at both high and low velocities. They are easily cleaned by regular dishwashing methods and are simple and easy to remove and install.

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another outstanding design development from

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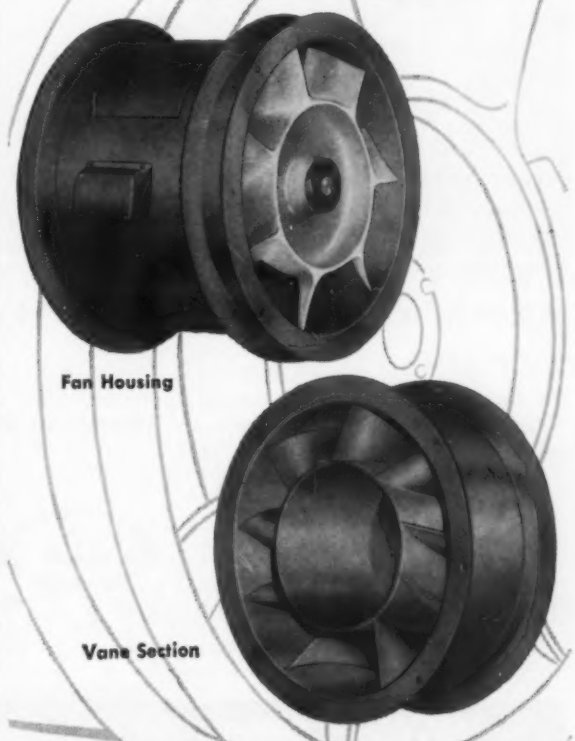


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**with removable vane sections**

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ASH AND BRANCH STREETS PIQUA, OHIO

## MEETINGS & CONVENTIONS

*Continued*

*OCT.* 23-26 — 1961 *Conference and Exhibition of the South Central Region of the National Association of Corrosion Engineers.* Shamrock Hilton Hotel, Houston, Tex. Information: National Association of Corrosion Engineers, 1061 M & M Building, Houston 2, Tex.

*NOV.* 12-15 — *Air-Conditioning and Refrigeration Institute Annual Meeting.* The Homestead, Hot Springs, Va. Information: Air-Conditioning and Refrigeration Institute, 1346 Connecticut Ave., N.W., Washington 6, D.C.

*NOV.* 13-16 — *National Warm Air Heating and Air Conditioning Association Annual Convention.* La Salle Hotel, Chicago, Ill. Information: NWAHACA, 640 Engineers Bldg., Cleveland 14, Ohio.

*NOV.* 13-17 — *American Public Health Association, 89th Annual Meeting, Air Pollution Session.* Cobo Hall, Detroit, Mich. Information: American Public Health Association, 1790 Broadway, New York 19, N.Y.

*NOV.* 26-*DEC.* 1— *The American Society of Mechanical Engineers Winter Annual Meeting.* Statler Hilton Hotel, New York, N.Y. Information: L. S. Dennegar, director of public relations, American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N.Y.

### 1962

*FEB.* 12-15 — *Air Conditioning and Refrigeration Industry 12th Exposition.* Pan-Pacific Auditorium, Los Angeles, Calif. Information: George E. Mills, Air-Conditioning and Refrigeration Institute, 1346 Connecticut Ave., N.W., Washington 6, D.C.

*MARCH* 19-23 — *National Association of Corrosion Engineers Annual Conference and* 1962 *Corrosion Show.* Kansas City Auditorium and Muehlebach Hotel, Kansas City, Mo. Information: National Association of Corrosion Engineers, 1061 M & M Building, Houston 2, Tex.


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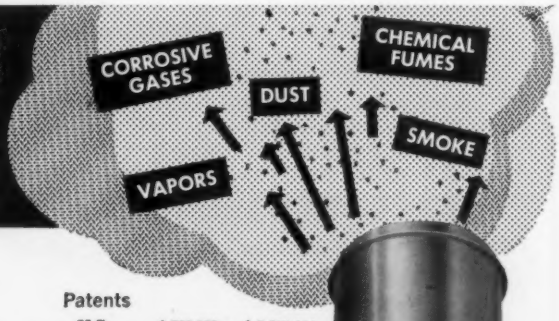
LOWER MAINTENANCE COSTS!
NO MOTORS, FANS OR BEARINGS IN EXHAUST LINE
PERFECT DRAFT-CONTROL BY Quickdraft

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*FOR* INDUSTRY . . . Now you can boost the combustion efficiency of your boilers, regardless of the fuel you use. Quickdraft power-draft units provide instant controlled draft and completely remove all combustion, corrosive and noxious fumes at high temperature without passing them through the blower and motor. Maintenance costs are drastically reduced. Specify a Quickdraft unit to meet your particular requirements from a wide selection of various sizes.

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Patents
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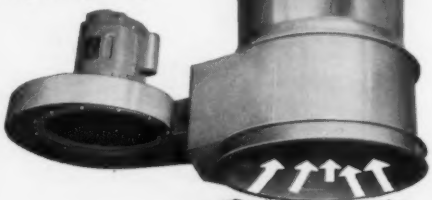
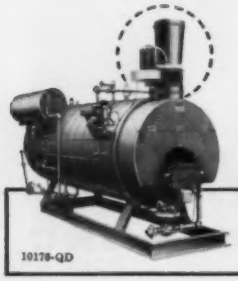
British 802,920
Canadian 593,817
Other patents pending





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**NEAT APPEARANCE,** distinctive chrome-plated dial ring.

**WIDE TEMPERATURE RANGES,** available in both Fahrenheit and Centigrade dials, temperature ranges from -100° to 1000° F.

**EASY TO READ,** modern aluminum dial, large figures.

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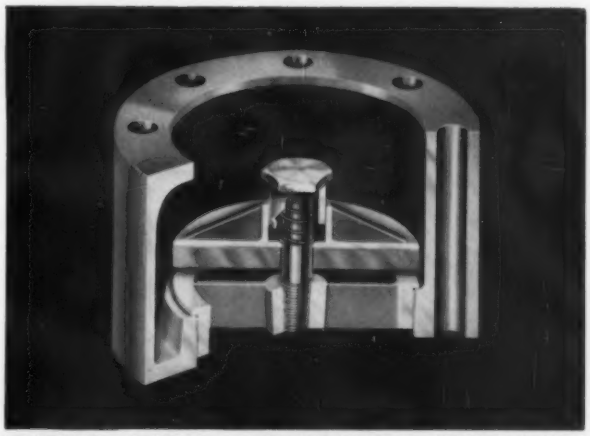

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. . . because the pressure sensitive spring closes the valve instantly and silently **before** reverse flow can start.

CPV SILENT CHECK VALVES are the positive, low cost way to eliminate water hammer, back drop and line surge in any piping system. Two point, guided lift design means disc can't tilt. Available in wide range of materials including stainless steel in sizes from ½-in. to 20 in. or more. Get the facts from your CPV representative or write for Catalog 600.

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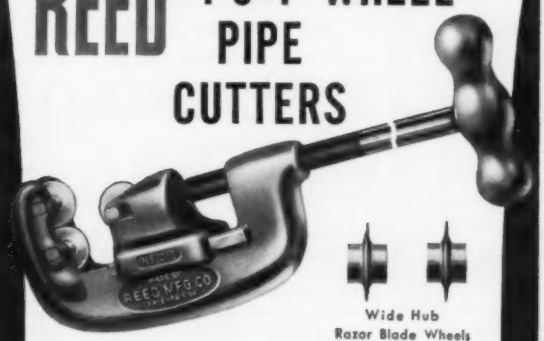
# REED 1-3-4 WHEEL PIPE CUTTERS




Wide Hub Razor Blade Wheels

The Reed Pipe Cutters in this series are the easiest-to-use and the cleanest cutting tools in their size range. In the roller model, the single wheel is in the sliding block where it is always in full sight with the cut-off mark. The 4-wheel model is excellent for close-quarter work since it operates with an easy ratchet-like action through a quarter revolution. Reed Razor Blade Wheels cut easily, track perfectly, and leave minimum burr. Available in three size ranges: ⅛" to 1¼", ⅛" to 2" and 1" to 3".

*At better jobbers, or write for circular*

REED MANUFACTURING COMPANY

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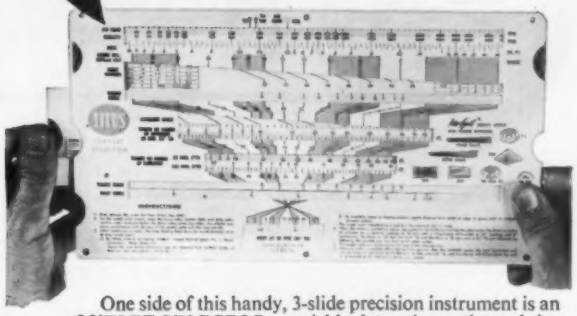
# NEW TITUS SLIDE RULE

**Combination Outlet Selector & Air Flow Calculator for ENGINEERS & CONTRACTORS**



One side of this handy, 3-slide precision instrument is an *OUTLET SELECTOR* to quickly determine outlet and size based on available space and noise criteria. Other side of rule is *FLOW CALCULATOR* to determine air flow rate for any diffuser or grille from velocity measurements in the field.

Developed by H. Straub, P.E., Director of Titus Research Laboratory. Based on over 5 years of research. 6" x 11" in size. *Furnished complete with 24-page Instruction and Information Booklet for $2.50.*

MAIL COUPON WITH $2.50 TODAY

**TITUS MFG. CORP., WATERLOO, IOWA**

Please send Titus Slide Rule complete with instruction booklet. Enclosed is my check for $2.50.

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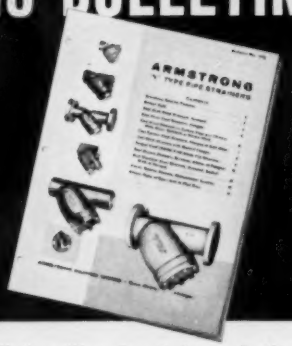
to compare strainer design, manufacture, value . . .




This new 12 page bulletin will make strainer selection simpler for you. It gives full design data on Armstrong Strainers, extensive screen information and specifications and prices for all popular sizes of cast iron, cast carbon steel (WCB), cast chrome moly steel (WC6), forged steel (ASTM A-182, grade F-22), cast bronze and stainless steel strainers with screwed, socket weld, Silbraz, butt weld or flanged connections. Ask for Bulletin 170.

The Armstrong line is the value line in strainers. They give you an exclusive combination of design features at a price no higher than for any good strainer.

103-YS

ARMSTRONG STRAINERS

Made by the makers of Armstrong Steam Traps

ARMSTRONG MACHINE WORKS

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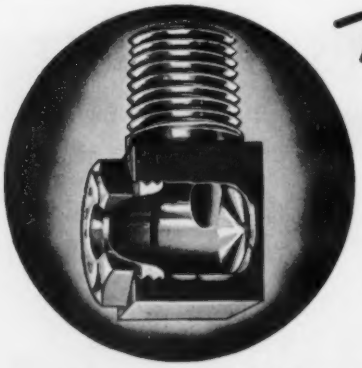

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NOZZLES for AIR WASHERS

These are "non-clogging" nozzles with a single large tangential lead hole to the swirl chamber that will never clog from any impurities small enough to pass through the orifice. Swirl chamber is conical on both ends and pivots liquid like a top to produce an exceptionally fine, evenly distributed, balanced spray of about 80° included angle. Wider spray angles up to 130° can be furnished to order.

Standard material Brass. Also available in Stainless Steel and Monel. Pipe sizes from ⅛" to 1". ¼" size is 1-5/16" long and made from ⅝" square stock.

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*School Fires, an Approach to Life Safety* — A report prepared by the committee of safety to life from fire in elementary and secondary schools, Building Research Advisory Board, jointly with the committee on fire research, division of engineering and industrial research. Describes the various factors concerned in school fires, outlines the task of fire prevention, and gives an approach to solving the situation. Price, $2.50. — *Printing and Publishing Office, National Academy of Sciences-National Research Council,* 2101 *Constitution Ave., Washington* 25, *D.C.*

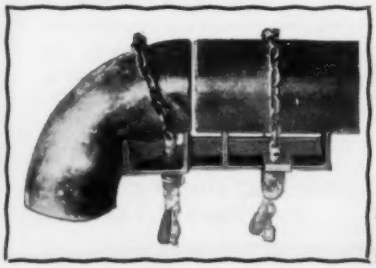
*SBI Boiler Rating Code, Eighth Edition* — The purpose of this code is to provide uniform methods of rating steel firebox boilers (except vertical types for over 15 psi pressure) which are manufactured in accordance with the American Society of Mechanical Engineers Boiler and Pressure Vessel Code. The publication contains eight sections: general; rating of Table 1 steel boilers; SBI ratings for Table 4A and Table 4B steel boilers; rating of Table 2 steel boilers; rating of Table 3 steel boilers and boiler-burner units; SBI Code for Testing Oil-fired Table 2 and Table 3 Steel Heating Boilers; SBI symbol; and definitions. Price, $2.00. — *Steel Boiler Institute, Inc.,* 1308 *Land Title Bldg., Broad and Chestnut Sts., Philadelphia* 10, *Pa.*


. . . enough JEWEL clamps cut erection costs

# PIPE WELDING CLAMPS

Jewel Pipe Clamps are lightweight — rigidly constructed — resist strain, heat and abuse.

FOR WELDING PIPE • FLANGES • ELBOWS • ANGLES —also PIPE MARKERS



Jewel Clamps align pipe perfectly, and hold it there until it is welded. Two sizes, ½" to 8"; 8" to 16". Write for details.

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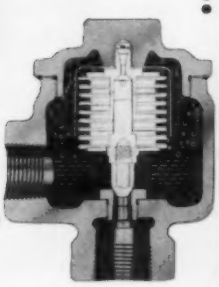

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Permits no leakage, assures precision positioning and positive shut off. Simple design and rugged construction, provide thousands of trouble free hours of operation.

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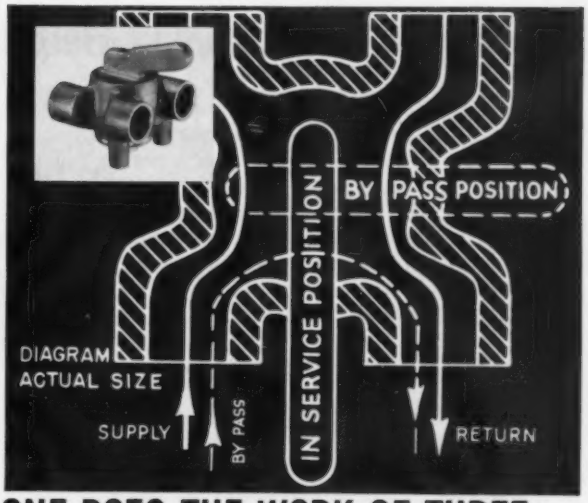


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Now—eliminate intricate piping connections for induction and fan-coil air conditioning systems and save space too! Replacing three-unit valve clusters at each coil, this single-control valve does it all—a ¼ turn opens the by-pass for the flushing operation and shuts off the water supply to the coil and control valve for maintenance. Another ¼ turn and service is restored. Accepts ½ or ⅝" O.D. copper tubing with soldered or flare-type connections. Write for specs and prices on No. 1831 By-Pass valve to...

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INDUSTRIAL
Red-Reading Mercury
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**EXCLUSIVE**
Gasket seals glass and frame. Provides dust-tight, moisture-tight, rattle-proof construction.

Over 15 Special features include:

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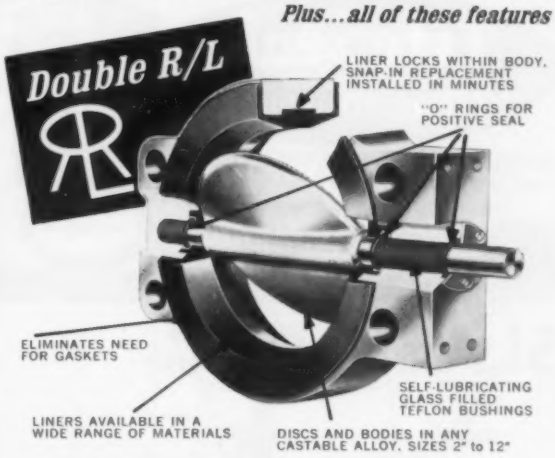
*NOW...*
## dependable bubble-tight shutoff
***Plus...all of these features***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LINER LOCKS WITHIN BODY. SNAP-IN REPLACEMENT INSTALLED IN MINUTES
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Can be used for on/off or throttling control, using manual and/or power actuators. CONTINENTAL EQUIPMENT COMPANY (a Division of Fisher Governor Company), Coraopolis, Pa.

**Write for Bulletin 91**

*If it flows through pipe anywhere in the world... chances are it's controlled by..*

FISHER Controls SINCE 1880

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American Air Filter Co., Inc.
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Cassady at Eighth
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Continental Air Filters, Inc.
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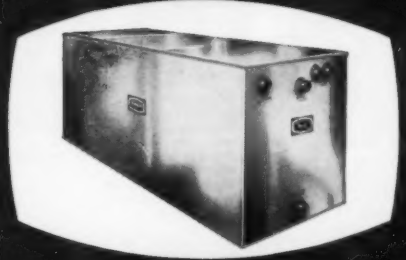

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